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# Decision rules for the 4T overwintering herring fishery in 4Vn

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## Abstract

Biological information concerning timing and locations of herring concentrations in 4Vn are presented to assist in the development of a decision rule on where to fish in 4Vn (Decision Rule 4). A computer simulation model is used to examine the consequences of catching various amounts of fish (Decision Rule 1).

These analyses determined that for Decision Rule 4: the general principle of fishing in areas where stocks are randomly mixed is most likely to be met in northern areas of 4Vn. Risk of fishing in areas where small vulnerable local stocks are concentrated is greater between Cape Smoky and Cape Dauphin, than north of Cape Smoky. Fishing below Cape Smoky increases the proportion of spring spawners in the catch. Therefore, given the declining situation in the Bras d'Or Lakes, the Cape Smoky line is appropriate at this time.

Similarly, for Decision Rule 1 it was determined that: the rule previously established, that the overwinter catch is not to exceed recent average landings, is still appropriate and would limit exploitation rates on local stocks within conservation target levels.



## Résumé

Les renseignements biologiques ayant trait aux moments et aux lieux des concentrations de hareng en 4Vn sont présentés afin de faciliter l'élaboration d'une règle de décision pour les lieux de pêche en 4Vn (Règle de décision 4). Un modèle de simulation informatique est utilisé pour examiner les conséquences de la capture de diverses quantités de poisson (Règle de décision 1).

Les analyses ont permis de déterminer que, pour la règle de décision 4, le principe général de la pêche dans des zones où les stocks sont mélangés de façon aléatoire sera très probablement respecté dans la partie nord de 4Vn. Le risque de pêcher dans des zones où des stocks locaux petits et vulnérables sont concentrés est plus important entre le cap Smoky et le cap Dauphin qu'au nord du cap Smoky. La pêche au sud du cap Smoky donne lieu à une augmentation de la proportion de géniteurs de printemps au sein des captures. Par conséquent, étant donné le déclin des populations dans les lacs Bras d'Or, la ligne passant par le cap Smoky apparaît appropriée.

De façon semblable, il a été déterminé, pour la règle de décision 1, que la règle antérieurement établie, à savoir que les captures d'hiver ne devraient pas excéder les débarquements moyens récents, demeure appropriée et devrait limiter le taux d'exploitation des stocks locaux en deçà des niveaux de conservation cibles.

## 1. Introduction

There are three areas where herring are harvested in mixed-stock overwintering aggregations in the Maritimes Region; the Northeast Atlantic coast of Cape Breton (4Vn), Chedabucto Bay, and Halifax. The biological objective, to keep exploitation rates within $F_{0.1}$ or other conservation targets on all stocks in these fisheries is similar in each area. For herring, in the Maritimes Region, these range from about 20% to 25%, averaged over the principal ages in a fishery. The objective of these Decision Rules is to allow a mixed stock fishery, where information on contributing stocks is incomplete, to proceed and still limit exploitation rates on all stocks within conservation target levels.

Several issues in the 4Vn area have lead to the development of these decision rules. Of primary importance is that 4Vn is an overwintering area for 4T and other stocks of 4Vn, Bras d'Or lakes, and 4WX origin. Each of these herring stocks has a different migratory pattern into and within 4Vn. Thus, depending on where and when fisheries directed towards these stocks occur, other stocks may also be vulnerable to those fisheries as by-catch. This incidental catch is of particular concern when one of the stocks, vulnerable as by-catch, is very small or in a declining situation. This concern for a small and declining stock (Bras d'Or Lakes herring) and the unknown size and status of other local origin 4Vn stocks is a major management issue in the 4Vn herring fisheries. Because of the concern for these stocks and the possibility of incidental harvests by an overwintering fishery, several in-season management decisions were made in 1996 that interrupted the overwintering fishery. This situation is not satisfactory for the herring industry and so the concept of Decision Rules that would allow a fishery to continue in a safe manner, but whose affects would be evaluated as part of the assessment process was initiated. This document is the second one to evaluate these Decision Rules for 4Vn in particular, and mixed-stock fisheries in general.

The situation often encountered in a mixed stock fishery is that of a large stock migrating into an area which has one or more smaller local spawning stocks. In some cases, there may also be large or small fish stocks migrating into the mixed stock fishery from several areas. The ideal situation would be if the origin of all fish caught in a mixed stock fishery could be positively identified to stock origin, the size of each of these stocks was known, and removals of fish from these stocks in other fisheries was known. In this situation, determining the exploitation rates would simply be a matter of adding up the catches for each stock and dividing by the population size. After comparing these to the conservation targets, decisions could then be made to alter the fishery to reduce exploitation where it was too high or to make available other fishing opportunities in under-utilized areas. Often, however, the origin of the contributing stocks is not known, the size of each potentially contributing stock is also not known, and information on removals of stocks from other fisheries is incomplete. In these cases, advice for harvest decisions depends on identifying the probability that target fishing mortalities will be exceeded on individual stocks in particular situations. Once these probabilities are evaluated, specific operational considerations, or Decision Rules, can be established to ensure that the large stock predominates in the catch and that conservation objectives for all stocks are met. The results of the fishery are then evaluated against the Decision Rule objectives at a stock assessment review meeting, and any changes required to meet those objectives are recommended.

Previous documents (Anon., 1997) have indicated the general principles that would guide the assessment of the probabilities of exceeding target fishing mortalities on individual stocks. These were:

I. If mixing is random:

- Exploitation rates will on average be equal among all stocks, regardless of number of stocks.
- Exploitation rates will be more variable on the smaller stocks

II. If mixing is not random and fishing occurs where small stocks are concentrated:

- exploitation rates on small stocks will be much higher than those expected on the larger stocks.

It is thus important to identify situations which would lead to very high exploitation rates on the smaller, more vulnerable, stocks in an area. To identify these situations, information on the relative sizes of the contributing stocks, areas where small stocks are concentrated, and differences in biological characteristics, so that mixtures can be evaluated, are required. One way to ensure a reduction in probability of high exploitation on small stocks is to limit fishing activity to areas where small portions of large aggregations could be harvested rather than large portions of small aggregations.

The 4T overwintering fishery in 4Vn (Fig. 1) does not fit the ideal. The characteristics of the overwintering fishery and the large 4T migrating stock are relatively better known and defined than the information on the abundance, catches, and biological characteristics of local stocks. As a result, the 4T overwintering fishery in 4Vn is a case where specific rules are needed in order to allow the fishery to proceed in such a manner that the uncertainties are taken into account, that the large migrating 4T stock predominates in the catch, and that exploitation rates on local stocks are limited to conservation target levels.

The Decision Rules derived in this document refer specifically to the 4T herring overwintering fishery in 4Vn. These Decision Rules and the principles outlined above, however, apply generally to mixed stock fisheries and, combined with the examples from this overwintering fishery, may be used to guide the development of Decision Rules for other mixed stock fisheries

**2. Decision Rules for 4Vn - Background**

Previously four decision rules were addressed to guide the 1997 4Vn herring purse seine overwintering fishery. The issues addressed are identified below and the decisions or rules made are in bold and quoted from Anon (1997) as follows:

Decision Rule 1: How many fish to catch? **Overwinter catch not to exceed recent average landings, for example 1990-1996.**

Decision Rule 2: When to start? Starting date: **November 1**

Decision Rule 3: Size of fish to catch? **No more than 10% of catch by number can be below 24.5 cm fork length.**

Decision Rule 4: Fishing Area? **Restrict fishing to area of 4T winter distribution, position of boundary to be determined among science, management, and industry.**

This paper examines Fishing Area (Decision Rule 4) because it was not previously resolved (Anon., 1997). It also examines How many fish to catch (Decision Rule 1) because this rule may be affected by the decision on where to fish. There is no additional information at this time that warrants a re-examination of Decision Rule 2: When to Start and Decision Rule 3: Size of fish to catch.

A desired result of the Decision Rule approach is to begin defining a model that would guide the acquisition of additional knowledge that would indicate when changes are to be made in these decision rules.

While the information presented here is focused on concerns related to the 4T overwintering fishery in 4Vn; the management of other fisheries in the area will also be affected by the general principles outlined above. For example, local inshore fisheries may also occur on mixtures of stocks depending on when and where these fisheries occur and the amounts of fish they are allocated.

**3. Description of the overwintering fishery**

Catches in the 4T herring overwintering fishery in 4Vn in 1997 were 3605t, of which 96% were fall spawners (Table 1). Landings, for both spawning groups combined, from 1978 to 1997, ranged from 2600t to 4700t. From 1978 to 1986, fall spawners ranged from 50% to 80% of the catch. In recent years, from 1987 to 1997, a higher proportion, 80% to 96%, of the catch has been fall

spawners. A survey conducted by a purse seiner, in 1997, to investigate biomass south of Cape Smoky resulted in an additional catch of 59t in this area as compensation for survey costs. Fall spawners were 95% of the this survey catch.

The fishery began in 1997 on November 1 and ended November 22. Peak landings, in 1997, occurred on November 12. At least one sample was collected each day of the fishery except November 8 (Table 2). Since 1990, this fishery has been completed by the end of November. The exception was 1996, when one night of fishing occurred on December 3-4.

In 1997, for the first time, fishing was restricted to north of Cape Smoky for the duration of the overwintering fishery (Fig. 1). This restriction came about because of concern over potential catches of Bras d'Or Lakes spring spawning herring, that might occur from fishing in the St. Ann's Bay-Bird Islands area. On December 3-4, 1996, purse seine catches of 524t occurred of which 167t were spring herring. Of these 167t, 64t were identified as 4T origin. It could not be determined which stock the remaining 103t came from, 4T or the Bras d'Or Lakes. Because of the concern over the declining situation in the Bras d'Or Lakes spring spawning stock, the fishery was then restricted to north of Cape Smoky, where harvests of spring spawners are a very low percentage of the catch. After the restriction to limit fishing north of Cape Smoky was implemented, no additional fishing occurred in 1996. An additional change, made in 1997, was that seiners were permitted to fish in 4T and 4Vn during the overwintering fishery but no fishing occurred in 4T.

Year-classes dominant in the 4T population can be followed through the 4Vn fishery. For example, the 1983 year-class appeared first as four year-olds in 1987, and the 1987 year-class in 1991 (Fig. 2). Recent 4T above average year-classes, 1990 and 1992, are also dominant in the 4Vn overwintering fishery (Fig. 2).

The 1993 year-class which is estimated to be very large in the 4T population is not as evident in the overwintering catch. The requirement to release all fish < 24.5 cm fork length, which includes a portion of age 4 herring, is consistent with this difference between the age 4 population and the age 4 overwintering catch (Fig. 3).

Spring spawners have been a much smaller percentage (Table 1) and number in the catch in recent years than prior to 1986 (Fig. 4). Age 6, the 1991 year-class which is dominant in 4T, was also dominant in 1997 catches in 4Vn (Fig. 5).

Declines in mean weight-at-age were similar in the 4T population and the overwintering catch (Fig. 6). Average mean weight at age, however, was slightly higher in 1997 than 1996 for fall and spring spawners but was still lower than during the late 1980s and early 1990s (Tables 3,4).

These similarities in dominant year-classes and mean weight-at-age trends are consistent with the majority of the overwintering catch coming from herring of 4T origin.

In 1996 the fishery was closed from November 9 to 21 because catches of herring less than 24.5 cm fork length were higher than 10%. The purpose of this size regulation, described in Decision Rule 3, is to maintain the harvest of immature herring within the target fishing mortalities projected for the 4T stock and to protect local juvenile herring (Claytor 1997a). In 1996, catches of immature herring for 4T and 4Vn combined were within the 4T $F_{0.1}$ levels and were 7% of the total spring and fall spawner catch (Claytor 1997a). The average length of a 3 year-old herring caught in 4Vn is about 27.5cm total length (unpublished data). In 4T, during fall spawning, about 50% of three year-old herring are mature (unpublished data). Percentage of catches <27.5cm by number for 1996 were 19% and 18% for 1997 (Table 5). These results suggest that the amounts of small fish landed in 4Vn are meeting the objectives of Decision Rule 3 and that it is still applicable.

## 4. Decision Rule 4: Fishing Area?

### 4.1 Questions

The following questions need to be answered to determine where to fish:

1. What is the location of the large 4T migrating stock during the timing set by Decision Rule 2 for the overwintering fishery? Decision Rule 4 requires that the overwintering fishery be restricted to this area.
2. What local stocks are in the area of the overwintering fishery and what is their relative size compared to the 4T migrating stock? The general principles require this information to determine the probability that fishing in a particular area will be on a random mixture of stocks or will be disproportionately on concentrations of small local stocks.
3. What are the biological characteristics of the local stocks? This information will help assess the effects of all current fishing practices on these populations.
4. What are the biological characteristics of local 4Vn stocks compared to the large 4T migrating stock? This comparison will help determine the relative proportions of stocks mixing in the overwintering catch.

These questions and issues are dealt with collectively below.

### 4.2 Location of major concentrations during the time of the overwintering fishery

Determining the location of the major concentrations during the overwintering fishery indicates the areas where the large 4T migrating stock is likely to be during the fishery and where the requirement for random mixing is most likely to be met.

Historical information from the fishery and acoustic surveys identifies areas where herring are concentrated after the November 1 fishery starting date. Acoustic survey results, using research vessels from 1990 to 1997, and a purse seiner in 1997, indicate two areas of fish concentration, one in Aspy Bay and one off New Waterford-Glace Bay south of the Cape Dauphin Line, and low biomass indices for the St. Ann's Bay-Bird Islands area (Figs. 7, 8, 9).

Examination of spawning group identifies areas where mixtures of 4T and local stocks are most likely to occur. The percentage of spring spawners in the surveys, has always been less than 10% in the Aspy Bay area but has been as high as 27% south of Cape Dauphin (Figs. 7, 8, 9).

The overwintering fishery shows this same pattern. In Aspy Bay, where most of the fishing has occurred recently, the percentage of spring spawners has been less than 10% except for 1996 (Fig. 10). In 1997, fishing occurred exclusively in Aspy Bay and the percentage of spring spawners was 4% (Table 1). When fishing has occurred in the St. Ann's Bay-Bird Islands area, the percentage of spring spawners is higher than in Aspy Bay but is similar to the percentage of spring spawners in the 4T population (Table 6).

In Aspy Bay, the relatively high numbers of fall spawners from 4T, estimated from fall surveys, migrating into 4Vn would be very much larger than any of the small local fall spawning stocks in that area.

The St. Ann's Bay-Bird Islands area has been the area where spring spawners from Bras d'Or lakes have been caught in the purse seine fishery in the past (see tagging discussion below). Relatively low biomass estimates from fall surveys are also observed in this area compared to north of Cape Smoky.

These results indicate that for areas north of the Cape Dauphin Line:

- The requirement for random mixing and the location of the 4T migrating stock is most likely to be met north of Cape Smoky.
- The higher percentage of spring spawners, south of Cape Smoky and lower biomass near St. Ann's Bay-Bird Islands area, indicate that the area south of Cape Smoky is more likely to be a

mixture of 4T and local stocks and less likely to be an area of random mixing than north of Cape Smoky.

**4.3 Location of major concentrations at times other than the overwintering fishery**

Examinations of major concentrations at times other than the overwintering fishery provides information on the locations and relative sizes of local stocks compared to the larger 4T migrating stock.

A comparison of the January, July, and September bottom trawl surveys provides information on the relative size of the migrating 4T stock compared to local stocks. This comparison is useful because during the January survey the entire 4T stock is in the overwintering area, and during July and September all herring observed are assumed to be of local origin.

January bottom trawl surveys to investigate winter fish distributions generally found herring in distinct concentrations in the north, middle, and southern portions of 4Vn (Figs. 11, 12, 13). Herring were observed in the July and September bottom trawl surveys only in the St. Ann's Bay-Bird Islands area and south of the Cape Dauphin Line. No major concentrations were observed north of Cape Smoky (Figs. 14-19).

Minimum trawlable biomass in the July survey ranged from 0 to 39,000 tonnes from 1970 to 1996 and from 5,000 to 9,000 tonnes in the September survey (Table 7). In comparison, acoustic survey estimates ranged from 4,000 to 440,000 tonnes during 1984-97 (Table 7).

Ages of fall spawners in the 4Vn September 1994 and 1995 surveys do not show any sign of the large 1990 year-class that was dominant in the 4T population and 4T portion of the September bottom trawl survey in those years (Fig. 20). Maturity stages of these fish were greater than 90% spent, indicating they were of local origin.

Local fisheries also provide information on the location of concentrations at times other than the overwintering fishery. Catches of herring have occurred in trapnets set in Aspy Bay during May, June, and July from 1989 to 1997 (Table 8). Ages of spring and fall spawners in these trapnets have a similar age distribution to 4T, except for 1995 (Figs. 21, 22).

The distribution of lobster licenses indicates that most of the effort for herring as bait is probably south of Cape Smoky (Fig. 23). This situation depends on the assumption that fishing and catch of herring for bait is directly related to the number of lobster licenses in each area. This license distribution is important because the lobster fishery was reported, at a workshop held in Sydney, Feb. 1997, to last about 50 days and require about 300 pounds/day of bait per license. If this amount were all herring and were harvested locally, then the total herring catch in the bait fishery could be as high as 3500 tonnes.

Historical tagging studies also indicate areas where local stocks may be vulnerable during the overwintering fishery. From April 14 - May 1, 1981, 2975 herring were tagged in St. Ann's Bay. Of the 38 tags recovered, 8 were recovered from Bras d'Or lakes during the spring in 1981 and 1982 combined, and 25 from the purse seine fishery in 4Vn during October to December of 1981. Although unadjusted for effort, these results indicate the presence of Bras d'Or Lakes herring in the St. Ann's Bay area during the time of the overwintering fishery (Simon and Stobo 1983). These results are summarized below:

| Recovery Location | Ap-June | July-Sep. | Oct.-Dec | Total |
|---|---|---|---|---|
| 4Vn | 1 | | 25 | 26 |
| Bras d'Or | 8 | | | 8 |
| 4Wa | | 1 | | 1 |
| 4T | 2 | 1 | | 3 |

Thus, an overwintering fishery in St. Ann's Bay has the potential for catching local stocks from Bras d'Or Lakes.

A number of points are relevant with respect to the potential impact of a fishery in this area would have on Bras d'Or Lakes herring.

First, the Bras d'Or Lakes spring spawning component has declined in recent years. Herring have been absent from traditional spawning beds, low larval densities are observed during surveys, and fishing effort in the Lakes has increased and become more concentrated in the last two years (Stephenson et al. 1998).

Second, the age structure of spring spawners caught in the St. Ann's Bay area in 1996 suggests that 4T spring spawners would predominate in catches from this area. For example, age structure of spring herring caught in Aspy Bay were similar to those caught in St. Ann's Bay-Bird Islands area in 1996. These ages were also similar to those expected from examinations of the 4T spring spawner population age structure. Dominant year-classes of spring spawners in the overwintering catch, with considerations for gillnet mesh sizes were different from those in the Bras d'Or Lakes population (Fig. 24).

Third, herring have occasionally been taken under the ice in Bras d'Or Lakes, indicating that not all Bras d'Or Lakes herring overwinter in 4Vn.

These similarities and differences, while suggesting a predominance of 4T spring spawners in the St. Ann's Bay-Bird Islands area catch in 1996, do not guarantee a reduction in the risk to local spring stocks from fishing in this area.

The general principle of fishing in areas where stocks are randomly mixed is most likely to be met in northern areas of 4Vn. Risk of fishing in areas where small vulnerable local stocks are concentrated is greater between Cape Smoky and Cape Dauphin, than north of Cape Smoky. Fishing below Cape Smoky increases the proportion of spring spawners in the catch. Fall spawning stocks local to areas south of Cape Dauphin are not likely to be found north of Cape Smoky during the overwintering fishery. Therefore, given the declining situation in the Bras d'Or Lakes and the small likelihood of southern fall spawning stocks in the area during the overwintering fishery, the Cape Smoky line is appropriate at this time.

**5. Decision Rule 1: How many fish to catch?**

Decision Rule 1 (Anon., 1997) states that the overwintering catch is not to exceed recent average landings, for example, 1990-1996. The relevant points leading to this conclusion were that the presence of a high proportion of age 11+ herring, of unknown stock origin, in northern local coastal fall fisheries (Neil's Harbour) and the continued presence of local fisheries, suggested that fishing levels, since 1983, had not been detrimental to local spawning components. While this was recognized as a weak biological rationale for advice, it was stated that until additional information becomes available on the 4Vn spawning components, it would form the current advice for catch allocations.

There is no additional information that can be used to directly assess fishing mortalities on the Neil's Harbour local stock. As a result, the general principles cited above are used to assess the effect that various harvest levels in the overwintering fishery may have on these stocks.

The magnitude of the effects that would result under different TACs and assumptions about school size and mixing of stocks was investigated using a previously developed computer simulation model (Claytor 1997b). Using this model, the relative changes in exploitation rate that would result from a range of TAC levels, a range of migratory situations for the 4T stock, and a range of local stock sizes were examined. For each analysis it was assumed that the school size was 40t for the migratory and local stocks. The range of levels of the 4T stock that had migrated to 4Vn during the fishery were 20,000t, 40,000t, and 120,000t out of the current estimated 4T fall spawner stock size of 350,000t. Local stock abundance ranged from 2,500t, 5,000t, 10,000t, and 20,000t. The TAC varied from 3,700t, 4,200t, 4,800t, and 8,400t and did not depend on the size of the 4T stock. The levels of 3,700t to 4,800t were chosen because they represent levels that have been suggested by various user groups. The 8,400t level was chosen so that an extreme situation could be examined.

Results of simulations, with TAC fixed at 4,200t, indicate that when a small proportion of the 4T stock has migrated to 4Vn, exploitation rates on local stocks between 10 and 30% can be expected (Fig. 25). If, however, a large portion of the 4T stock has migrated to the area, then exploitation rates of less than 10% can be expected (Fig. 25). These exploitation rates would be due to the overwintering fishery and would be additional to exploitation rates from other fisheries. This situation has been recognized and was the reason that November 1 was the chosen starting date, ensuring that most of the 4T migration is underway before fishing starts.

The worst situation develops when the local stock size is smallest, and so the consequences of differing levels of TAC were examined assuming the local stock size is 2500t. Two levels of 4T migration were examined (20,000t and 120,000 t). These results indicate that local stock exploitation rates will exhibit greater variation at low 4T migration levels (Fig. 26).

At the higher 4T migration rate, 120,000t, there was little relative difference among the 3,700 - 4,200 - 4,800t TAC levels. Exploitation rates resulting from the 8,400t TAC, as expected, were about twice as great as the lower rates (Fig. 26).

The risk of exceeding target fishing levels increases when fishing occurs before the large migratory stock is well underway. Acoustic and bottom trawl surveys conducted since 1984 indicate the 4T migration is well established by November 1. As a result, November 1 (Decision Rule 2) was chosen as the starting date for the 4Vn overwintering fishery. Under these conditions, expected exploitation rates on local stocks would be below target fishing levels and there would be little difference in risk of exceeding fishing mortality targets between TACs of 3,700 to 4,800t in northern fishing areas. These results support the continued application of Decision Rule 1 that the overwinter catch is not to exceed recent averages.

## 6. Acknowledgments

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Table 1. Catches by large seiners in 4T overwinter fishery in 4Vn from 1978 - 1997.

| Year | Spawning Group | | Total | TAC | Percent Fall |
|---|---|---|---|---|---|
| | Fall | Spring | | | |
| Fishery | | | | | |
| 78 | 1833 | 808 | 2641 | 8000 | 69 |
| 79 | 1418 | 1496 | 2913 | 3000 | 49 |
| 80 | 2981 | 870 | 3852 | 4500 | 77 |
| 81 | 2120 | 1162 | 3282 | 3000 | 65 |
| 82 | 2150 | 1373 | 3523 | 3000 | 61 |
| 83 | 2808 | 1167 | 3976 | 5000 | 71 |
| 84 | 3000 | 1004 | 4005 | 3500 | 75 |
| 85 | 2822 | 778 | 3600 | 3500 | 78 |
| 86 | 3105 | 1214 | 4319 | 4200 | 72 |
| 87 | 2093 | 279 | 2372 | 4200 | 88 |
| 88 | 2438 | 138 | 2576 | 4200 | 95 |
| 89 | 1959 | 159 | 2117 | 4200 | 93 |
| 90 | 3942 | 721 | 4663 | 4200 | 85 |
| 91 | 3871 | 921 | 4792 | 4200 | 81 |
| 92 | 3955 | 292 | 4247 | 4200 | 93 |
| 93 | 3722 | 219 | 3940 | 4200 | 94 |
| 94 | 2968 | 276 | 3244 | 4200 | 91 |
| 95 | 3990 | 153 | 4142 | 4200 | 96 |
| 96 | 3543 | 734 | 4276 | 6423 | 83 |
| 97 | 3462 | 143 | 3605 | 4200 | 96 |
| **Survey 4Vn** | | | | | |
| 97 | 56 | 3 | 59 | | 95 |
| **Total 97** | 3518 | 146 | 3664 | | 96 |

Table 2. Daily landings and boats fishing in 4T overwintering herring fishery in 4Vn for 1997. Number of fish sampled for detailed analysis and date of sampling are indicated.

| | Daily | | Cumulative | | Spawning Group | | |
|---|---|---|---|---|---|---|---|
| | | | | | Number of Fish sampled | | |
| Date | Catch | Boats | Catch | Boats | Fall | Spring | Number of Samples |
| **Fishery** | | | | | | | |
| 1101 | 141 | 4 | 141 | 4 | 42 | 2 | 1 |
| 1104 | 179 | 4 | 320 | 8 | 129 | 5 | 3 |
| 1107 | 330 | 6 | 650 | 14 | 47 | 2 | 1 |
| 1108 | 185 | 5 | 835 | 19 | | | |
| 1112 | 744 | 6 | 1579 | 25 | 46 | 1 | 1 |
| 1115 | 120 | 5 | 1699 | 30 | 49 | 0 | 1 |
| 1117 | 496 | 5 | 2195 | 35 | 125 | 14 | 3 |
| 1119 | 627 | 6 | 2822 | 41 | 83 | 7 | 2 |
| 1120 | 650 | 5 | 3472 | 46 | | | |
| 1122 | 134 | 2 | 3606 | 48 | 37 | 3 | 1 |
| **Total** | 3606 | 48 | | | 558 | 34 | 13 |
| **Survey** | | | | | | | |
| 1122 | 59 | 1 | 3531 | 47 | 95 | 11 | 2 |

Table 3. Catch-at-age and weights-at-age (kg) for 4Vn herring fall spawners, 1978-1997. Numbers are in thousands of fish.

**Mobile Gear**

| AGE | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 20 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 42 | 5827 | 628 | 377 | 1888 | 1352 | 997 | 827 | 604 | 816 | 441 | 26 | 0 | 0 | 0 | 25 | 15 | 14 | 237 | 166 |
| 3 | 563 | 2622 | 2865 | 541 | 3147 | 4652 | 3551 | 1987 | 2533 | 1613 | 833 | 559 | 697 | 2105 | 20 | 159 | 280 | 137 | 1335 | 3648 |
| 4 | 1601 | 656 | 2602 | 6800 | 3103 | 3651 | 4271 | 3920 | 5162 | 4138 | 1103 | 1408 | 2264 | 5406 | 1096 | 456 | 1964 | 551 | 7966 | 3134 |
| 5 | 1092 | 167 | 888 | 693 | 1428 | 2114 | 2790 | 2982 | 2394 | 1413 | 3328 | 1130 | 1524 | 2547 | 3273 | 1814 | 722 | 4374 | 2560 | 6278 |
| 6 | 842 | 100 | 655 | 591 | 359 | 584 | 775 | 927 | 1375 | 735 | 2394 | 2443 | 413 | 750 | 1427 | 4357 | 2426 | 1266 | 3309 | 957 |
| 7 | 628 | 324 | 663 | 0 | 158 | 218 | 377 | 590 | 1770 | 1040 | 575 | 460 | 2716 | 856 | 1474 | 1687 | 3193 | 3844 | 1657 | 1560 |
| 8 | 366 | 0 | 636 | 206 | 40 | 50 | 66 | 66 | 967 | 620 | 734 | 684 | 642 | 1266 | 990 | 1473 | 984 | 3294 | 1176 | 561 |
| 9 | 449 | 0 | 905 | 236 | 47 | 83 | 58 | 130 | 245 | 165 | 346 | 429 | 857 | 1309 | 1379 | 1594 | 695 | 967 | 887 | 843 |
| 10 | 280 | 0 | 638 | 0 | 0 | 0 | 0 | 0 | 75 | 75 | 183 | 123 | 1686 | 539 | 983 | 1564 | 829 | 909 | 579 | 519 |
| 11+ | 156 | 0 | 493 | 0 | 57 | 38 | 19 | 48 | 7 | 22 | 79 | 292 | 3033 | 1699 | 4317 | 2587 | 1689 | 1732 | 589 | 635 |
| | 6019 | 9696 | 10973 | 9444 | 10227 | 12742 | 12904 | 11477 | 15137 | 10657 | 10028 | 7554 | 13832 | 16477 | 14959 | 15716 | 12797 | 17088 | 20295 | 18299 |

**Mobile Gear**

| AGE | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0380 | 0.0390 | 0.0350 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.1930 | 0.1070 | 0.1300 | 0.0800 | 0.1180 | 0.1410 | 0.1260 | 0.1140 | 0.0890 | 0.0750 | 0.0960 | 0.1200 | 0.0000 | 0.0000 | 0.0000 | 0.0280 | 0.0910 | 0.0850 | 0.0850 | 0.0860 |
| 3 | 0.1830 | 0.1760 | 0.1650 | 0.1900 | 0.1950 | 0.1900 | 0.1990 | 0.2010 | 0.1480 | 0.1450 | 0.1590 | 0.1640 | 0.1730 | 0.1440 | 0.1320 | 0.1180 | 0.1390 | 0.1280 | 0.1220 | 0.1430 |
| 4 | 0.2470 | 0.2260 | 0.2330 | 0.2090 | 0.2360 | 0.2380 | 0.2410 | 0.2470 | 0.1840 | 0.1860 | 0.2090 | 0.2080 | 0.2030 | 0.1920 | 0.1800 | 0.1530 | 0.1610 | 0.1610 | 0.1460 | 0.1688 |
| 5 | 0.3040 | 0.2740 | 0.3040 | 0.2810 | 0.2570 | 0.2620 | 0.2660 | 0.2690 | 0.2200 | 0.2110 | 0.2400 | 0.2360 | 0.2240 | 0.2230 | 0.2090 | 0.1780 | 0.1800 | 0.1920 | 0.1650 | 0.1869 |
| 6 | 0.3320 | 0.2980 | 0.3370 | 0.3150 | 0.2940 | 0.2960 | 0.2930 | 0.2980 | 0.2540 | 0.2540 | 0.2610 | 0.2740 | 0.2650 | 0.2480 | 0.2380 | 0.2040 | 0.2120 | 0.2130 | 0.1860 | 0.2197 |
| 7 | 0.3560 | 0.3460 | 0.3660 | 0.0000 | 0.3250 | 0.3240 | 0.3190 | 0.3170 | 0.2600 | 0.2610 | 0.2940 | 0.2910 | 0.2920 | 0.2630 | 0.2470 | 0.2270 | 0.2300 | 0.2200 | 0.2060 | 0.2239 |
| 8 | 0.3740 | 0.0000 | 0.3920 | 0.4280 | 0.3610 | 0.3600 | 0.3540 | 0.3510 | 0.2930 | 0.2970 | 0.3190 | 0.3100 | 0.3150 | 0.2970 | 0.2760 | 0.2460 | 0.2470 | 0.2490 | 0.2280 | 0.2472 |
| 9 | 0.3880 | 0.0000 | 0.4000 | 0.4140 | 0.3960 | 0.4050 | 0.3590 | 0.3790 | 0.3280 | 0.3300 | 0.3330 | 0.3410 | 0.3360 | 0.3070 | 0.2860 | 0.2690 | 0.2820 | 0.2670 | 0.2380 | 0.2568 |
| 10 | 0.3990 | 0.0000 | 0.4140 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.3200 | 0.3180 | 0.3520 | 0.3370 | 0.3420 | 0.3210 | 0.2850 | 0.2830 | 0.2990 | 0.2900 | 0.2630 | 0.2913 |
| 11+ | 0.4290 | 0.0000 | 0.4350 | 0.0000 | 0.4210 | 0.4190 | 0.4080 | 0.4210 | 0.4460 | 0.3920 | 0.3700 | 0.3480 | 0.3470 | 0.3540 | 0.3300 | 0.3110 | 0.3240 | 0.3390 | 0.3220 | 0.3464 |
| | 0.3050 | 0.1460 | 0.2720 | 0.2250 | 0.2100 | 0.2200 | 0.2330 | 0.2460 | 0.2050 | 0.1960 | 0.2430 | 0.2590 | 0.2850 | 0.2350 | 0.2640 | 0.2370 | 0.2320 | 0.2340 | 0.1750 | 0.1944 |

Table 4. Catch-at-age and weights-at-age (kg) for spring spawners caught by purse seines in 4Vn, 1978-1997. Numbers are in thousands of fish.

**Mobile Gear**

| AGE | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 58 | 5679 | 349 | 595 | 1525 | 302 | 522 | 615 | 117 | 73 | 0 | 0 | 8 | 0 | 0 | 16 | 0 | 0 | 0 | 20 |
| 2 | 809 | 5007 | 2614 | 2829 | 3074 | 3383 | 1759 | 953 | 929 | 226 | 214 | 0 | 218 | 167 | 28 | 43 | 35 | 36 | 72 | 61 |
| 3 | 978 | 383 | 901 | 1833 | 1994 | 1561 | 1702 | 1129 | 4064 | 827 | 132 | 105 | 552 | 108 | 11 | 27 | 474 | 13 | 551 | 88 |
| 4 | 358 | 0 | 143 | 0 | 667 | 526 | 636 | 636 | 1466 | 441 | 145 | 180 | 608 | 990 | 74 | 51 | 187 | 289 | 209 | 37 |
| 5 | 330 | 0 | 117 | 438 | 362 | 289 | 371 | 418 | 0 | 0 | 127 | 99 | 701 | 289 | 182 | 176 | 138 | 104 | 1442 | 19 |
| 6 | 455 | 298 | 277 | 0 | 0 | 0 | 0 | 0 | 265 | 64 | 0 | 219 | 333 | 134 | 573 | 265 | 208 | 113 | 932 | 156 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 0 | 218 | 381 | 0 | 150 | 183 | 141 | 79 | 10 |
| 8 | 114 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 413 | 67 | 29 | 109 | 35 | 1157 | 0 | 120 | 53 | 27 | 27 | 43 |
| 9 | 14 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 186 | 0 | 0 | 83 | 4 | 96 | 116 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 186 | 0 | 0 | 0 | 8 | 4 | 31 |
| 11+ | 32 | 0 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 194 | 148 | 0 | 0 | 20 | 64 | 51 |
| | 3148 | 11367 | 4516 | 5695 | 7622 | 6061 | 4990 | 3751 | 7254 | 1698 | 706 | 712 | 2819 | 3792 | 1016 | 848 | 1361 | 755 | 3477 | 631 |

**Mobile Gear**

| AGE | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.071 | 0.097 | 0.110 | 0.106 | 0.100 | 0.118 | 0.099 | 0.090 | 0.056 | 0.057 | 0.000 | 0.000 | 0.079 | 0.000 | 0.000 | 0.059 | 0.000 | 0.000 | 0.070 | 0.0695 |
| 2 | 0.174 | 0.154 | 0.156 | 0.182 | 0.166 | 0.168 | 0.169 | 0.168 | 0.121 | 0.121 | 0.123 | 0.000 | 0.157 | 0.094 | 0.140 | 0.099 | 0.151 | 0.108 | 0.103 | 0.0957 |
| 3 | 0.228 | 0.181 | 0.215 | 0.230 | 0.221 | 0.220 | 0.224 | 0.234 | 0.156 | 0.158 | 0.181 | 0.145 | 0.217 | 0.113 | 0.179 | 0.163 | 0.149 | 0.126 | 0.136 | 0.1401 |
| 4 | 0.290 | 0.000 | 0.275 | 0.000 | 0.252 | 0.254 | 0.257 | 0.263 | 0.192 | 0.188 | 0.198 | 0.177 | 0.242 | 0.181 | 0.207 | 0.222 | 0.195 | 0.177 | 0.183 | 0.1911 |
| 5 | 0.323 | 0.000 | 0.314 | 0.369 | 0.289 | 0.301 | 0.300 | 0.313 | 0.000 | 0.000 | 0.242 | 0.213 | 0.279 | 0.228 | 0.243 | 0.233 | 0.187 | 0.199 | 0.221 | 0.1958 |
| 6 | 0.370 | 0.364 | 0.383 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.228 | 0.228 | 0.000 | 0.274 | 0.280 | 0.245 | 0.294 | 0.269 | 0.220 | 0.218 | 0.228 | 0.2447 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.287 | 0.000 | 0.319 | 0.265 | 0.000 | 0.296 | 0.296 | 0.241 | 0.265 | 0.2771 |
| 8 | 0.363 | 0.000 | 0.387 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.293 | 0.294 | 0.390 | 0.279 | 0.279 | 0.282 | 0.000 | 0.342 | 0.254 | 0.239 | 0.324 | 0.2859 |
| 9 | 0.480 | 0.000 | 0.483 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.360 | 0.335 | 0.000 | 0.000 | 0.296 | 0.321 | 0.310 | 0.3151 |
| 10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.341 | 0.335 | 0.000 | 0.000 | 0.000 | 0.317 | 0.314 | 0.3129 |
| 11+ | 0.433 | 0.000 | 0.441 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.329 | 0.392 | 0.000 | 0.000 | 0.314 | 0.318 | 0.3621 |
| | 0.257 | 0.132 | 0.193 | 0.204 | 0.180 | 0.193 | 0.201 | 0.207 | 0.167 | 0.165 | 0.195 | 0.223 | 0.256 | 0.243 | 0.287 | 0.258 | 0.203 | 0.202 | 0.211 | 0.2479 |

Table 5. Cumulative percentage by number and total length in seiner landing for 4T overwintering herring fishery in 4Vn for 1993 to 1997.

| Total Length | 93 | 94 | 95 | 96 | 97 |
|---|---|---|---|---|---|
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 |
| 22.5 | 0 | 0 | 0 | 1 | 0 |
| 23 | 0 | 0 | 0 | 1 | 1 |
| 23.5 | 0 | 0 | 0 | 2 | 1 |
| 24 | 0 | 0 | 0 | 2 | 1 |
| 24.5 | 0 | 0 | 0 | 3 | 1 |
| 25 | 1 | 0 | 0 | 4 | 1 |
| 25.5 | 1 | 1 | 0 | 5 | 2 |
| 26 | 1 | 2 | 1 | 8 | 3 |
| 26.5 | 2 | 3 | 1 | 11 | 6 |
| 27 | 2 | 5 | 1 | 15 | 11 |
| 27.5 | 3 | 8 | 2 | 19 | 18 |
| 28 | 3 | 12 | 3 | 25 | 26 |
| 28.5 | 4 | 16 | 4 | 31 | 33 |
| 29 | 5 | 19 | 6 | 38 | 42 |
| 29.5 | 7 | 23 | 10 | 45 | 51 |
| 30 | 10 | 28 | 20 | 53 | 60 |
| 30.5 | 14 | 34 | 30 | 60 | 68 |
| 31 | 19 | 41 | 41 | 67 | 75 |
| 31.5 | 27 | 50 | 51 | 73 | 80 |
| 32 | 35 | 58 | 60 | 78 | 85 |
| 32.5 | 43 | 65 | 68 | 84 | 88 |
| 33 | 51 | 71 | 75 | 88 | 90 |
| 33.5 | 57 | 76 | 80 | 90 | 92 |
| 34 | 62 | 79 | 83 | 93 | 94 |
| 34.5 | 68 | 83 | 86 | 95 | 95 |
| 35 | 73 | 86 | 89 | 96 | 96 |
| 35.5 | 78 | 89 | 91 | 97 | 97 |
| 36 | 84 | 92 | 93 | 98 | 98 |
| 36.5 | 88 | 95 | 95 | 98 | 98 |
| 37 | 92 | 97 | 97 | 99 | 99 |
| 37.5 | 95 | 99 | 98 | 99 | 99 |
| 38 | 98 | 99 | 99 | 100 | 100 |
| 38.5 | 99 | 100 | 100 | 100 | 100 |
| 39 | 100 | 100 | 100 | 100 | 100 |
| 39.5 | 100 | 100 | 100 | 100 | 100 |
| 40 | 100 | 100 | 100 | 100 | 100 |

Table 6. Percentage of spring spawners (tonnes) caught in the purse seine fishery in the two principal fishing areas, compared to percentage of spring spawners (age 4+) in the 4T population.

| | Fishery | | |
|---|---|---|---|
| Year | Aspy Bay | Bird - St. Ann's | 4T Population |
| 92 | 6 | 24 | 29 |
| 93 | 6 | 13 | 35 |
| 94 | 9 | | 30 |
| 95 | 4 | | 46 |
| 96 | 15 | 32 | 35 |
| 97 | 4 | | 27 |
| Average | 7 | 23 | 34 |

Table 7. Biomass estimates (t) from bottom trawl and acoustic surveys, 1970-1997. There was no bottom trawl survey in July 1974 and no sets were made in the bottom trawl survey in July 1980. There were no acoustic surveys in 4Vn in 1989 and 1994. The September bottom trawl survey in 4Vn occurrred only in 1994 and 1995.

| | Bottom Trawl | | Acoustic | |
|---|---|---|---|---|
| | Biomass (t) | | Biomass (t) | |
| Year | July | Sep | Sep-Dec | Dates |
| 70 | 6155 | | | |
| 71 | 2459 | | | |
| 72 | 1835 | | | |
| 73 | 10968 | | | |
| 74 | | | | |
| 75 | 739 | | | |
| 76 | 0 | | | |
| 77 | 667 | | | |
| 78 | 31 | | | |
| 79 | 0 | | | |
| 80 | | | | |
| 81 | 0 | | | |
| 82 | 0 | | | |
| 83 | 0 | | | |
| 84 | 1940 | | 75724 | Nov 17-26 |
| 85 | 0 | | 106865 | Nov 23-26 |
| 86 | 230 | | 127708 | Dec 1-12 |
| 87 | 39345 | | 443058 | Nov 17-24 |
| 88 | 81 | | 172886 | Nov 21-22 |
| 89 | 0 | | | |
| 90 | 9 | | 135249 | Nov 4-8 |
| 91 | 4997 | | 4418 | Oct. 21-23 |
| 92 | 0 | | 44845 | Oct. 14-22 |
| 93 | 417 | | 12512 | Oct 15-20 |
| 94 | 8788 | 8773 | | |
| 95 | 1773 | 5201 | 7295 | Sep 24-26 |
| 96 | 0 | | 21804 | Oct. 14-16 |
| 97 | n/a | | 17463 | Oct. 9-11 |

Table 8. Daily herring catches from mackerel trap in Aspy Bay, 1989-1997.

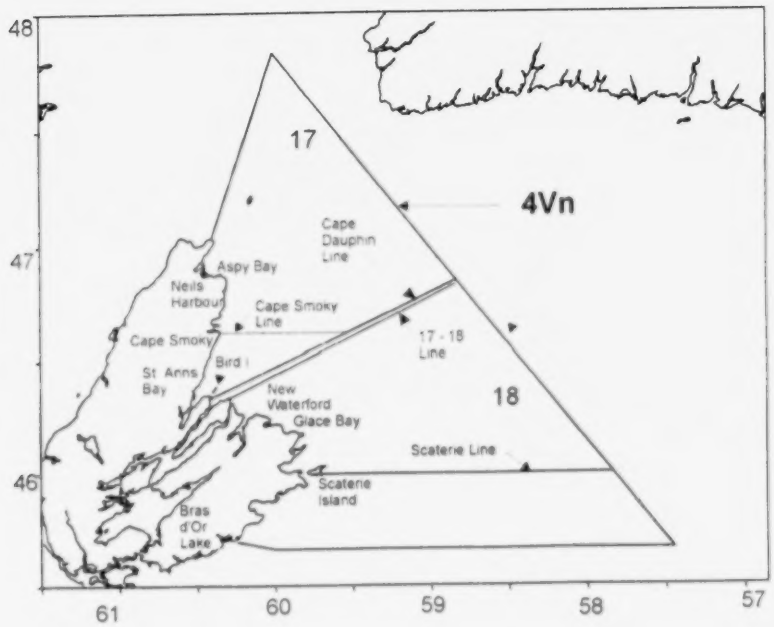
| | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Day | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. |
| 5 | 1 | 800 | 800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 2 | 2100 | 2900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 3 | 0 | 2900 | 10000 | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 4 | 9450 | 12350 | 19000 | 29000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 5 | 0 | 12350 | 0 | 29000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 6 | 0 | 12350 | 0 | 29000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 7 | 0 | 12350 | 0 | 29000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 8 | 0 | 12350 | 18000 | 47000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 550 | 550 | 0 | 0 |
| 5 | 9 | 0 | 12350 | 0 | 47000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 550 | 0 | 0 |
| 5 | 10 | 4280 | 16630 | 0 | 47000 | 50000 | 50000 | 0 | 0 | 6000 | 6000 | 0 | 0 | 0 | 0 | 20000 | 20550 | 0 | 0 |
| 5 | 11 | 0 | 16630 | 30000 | 77000 | 18000 | 68000 | 0 | 0 | 61000 | 67000 | 0 | 0 | 0 | 0 | 9000 | 29550 | 0 | 0 |
| 5 | 12 | 0 | 16630 | 0 | 77000 | 0 | 68000 | 0 | 0 | 20000 | 87000 | 0 | 0 | 0 | 0 | 0 | 29550 | 0 | 0 |
| 5 | 13 | 6900 | 23530 | 0 | 77000 | 16000 | 84000 | 0 | 0 | 9000 | 96000 | 0 | 0 | 0 | 0 | 0 | 29550 | 0 | 0 |
| 5 | 14 | 0 | 23530 | 0 | 77000 | 17870 | 101870 | 0 | 0 | 15000 | 111000 | 0 | 0 | 0 | 0 | 0 | 29550 | 0 | 0 |
| 5 | 15 | 16000 | 39530 | 35000 | 112000 | 3000 | 104870 | 0 | 0 | 6000 | 117000 | 0 | 0 | 0 | 0 | 50000 | 79550 | 0 | 0 |
| 5 | 16 | 44800 | 84330 | 40000 | 152000 | 0 | 104870 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 0 | 0 | 79550 | 0 | 0 |
| 5 | 17 | 44800 | 129130 | 30000 | 182000 | 17000 | 121870 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 0 | 0 | 79550 | 0 | 0 |
| 5 | 18 | 34400 | 163530 | 0 | 182000 | 9300 | 131170 | 0 | 0 | 0 | 117000 | 0 | 0 | 850 | 850 | 0 | 79550 | 0 | 0 |
| 5 | 19 | 0 | 163530 | 0 | 182000 | 0 | 131170 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 850 | 0 | 79550 | 0 | 0 |
| 5 | 20 | 15000 | 178530 | 0 | 182000 | 40000 | 171170 | 0 | 0 | 0 | 117000 | 0 | 0 | 450 | 1300 | 0 | 79550 | 0 | 0 |
| 5 | 21 | 0 | 178530 | 0 | 182000 | 51400 | 222570 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 1300 | 0 | 79550 | 0 | 0 |
| 5 | 22 | 17000 | 195530 | 0 | 182000 | 0 | 222570 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 1300 | 0 | 79550 | 0 | 0 |
| 5 | 23 | | 195530 | 10000 | 192000 | 0 | 222570 | 0 | 0 | 0 | 117000 | 0 | 0 | 0 | 1300 | 0 | 79550 | 0 | 0 |
| 5 | 24 | 0 | 195530 | 0 | 192000 | 0 | 222570 | 0 | 0 | 0 | 117000 | 0 | 0 | 200 | 1500 | 0 | 79550 | 0 | 0 |
| 5 | 25 | 0 | 195530 | 0 | 192000 | 0 | 222570 | 0 | 0 | 6000 | 123000 | 0 | 0 | 0 | 1500 | 0 | 79550 | 0 | 0 |
| 5 | 26 | 0 | 195530 | 0 | 192000 | 0 | 222570 | 0 | 0 | 0 | 123000 | 0 | 0 | 0 | 1500 | 0 | 79550 | 1350 | 1350 |
| 5 | 27 | 0 | 195530 | 0 | 192000 | 0 | 222570 | 0 | 0 | 0 | 123000 | 2000 | 2000 | 0 | 1500 | 8000 | 87550 | 0 | 1350 |
| 5 | 28 | 0 | 195530 | 15000 | 207000 | 0 | 222570 | 1500 | 1500 | 0 | 123000 | 7300 | 9300 | 0 | 1500 | 28000 | 115550 | 0 | 1350 |
| 5 | 29 | 0 | 195530 | 0 | 207000 | 0 | 222570 | 0 | 1500 | 0 | 123000 | 0 | 9300 | 0 | 1500 | 108000 | 223550 | 12500 | 13850 |
| 5 | 30 | 0 | 195530 | 8000 | 215000 | 0 | 222570 | 0 | 1500 | 0 | 123000 | 43500 | 52800 | 0 | 1500 | 0 | 223550 | 22500 | 36350 |
| 5 | 31 | 8000 | 203530 | 0 | 215000 | 0 | 222570 | 0 | 1500 | 0 | 123000 | 19000 | 71800 | 7000 | 8500 | 48000 | 271550 | 31000 | 67350 |

Table 8 (cont).

| | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Day | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. |
| 6 | 1 | 0 | 203530 | 17000 | 232000 | 0 | 222570 | 3000 | 4500 | 0 | 123000 | 8000 | 79800 | 0 | 8500 | 0 | 271550 | 39000 | 106350 |
| 6 | 2 | 0 | 203530 | 0 | 232000 | 0 | 222570 | 0 | 4500 | 0 | 123000 | 0 | 79800 | 0 | 8500 | 0 | 271550 | 16400 | 122750 |
| 6 | 3 | 0 | 203530 | 0 | 232000 | 11500 | 234070 | 0 | 4500 | 0 | 123000 | 5000 | 84800 | 0 | 8500 | 42000 | 313550 | 550 | 123300 |
| 6 | 4 | 2000 | 205530 | 0 | 232000 | 12000 | 246070 | 0 | 4500 | 0 | 123000 | 0 | 84800 | 0 | 8500 | 0 | 313550 | 2000 | 125300 |
| 6 | 5 | 0 | 205530 | 0 | 232000 | 70000 | 316070 | 0 | 4500 | 0 | 123000 | 2000 | 86800 | 0 | 8500 | 50000 | 363550 | 0 | 125300 |
| 6 | 6 | 0 | 205530 | 0 | 232000 | 15000 | 331070 | 0 | 4500 | 0 | 123000 | 0 | 86800 | 0 | 8500 | 0 | 363550 | 5000 | 130300 |
| 6 | 7 | 400 | 205930 | 0 | 232000 | 10000 | 341070 | 0 | 4500 | 0 | 123000 | 0 | 86800 | 0 | 8500 | 20000 | 383550 | 10000 | 140300 |
| 6 | 8 | 0 | 205930 | 0 | 232000 | 0 | 341070 | 0 | 4500 | 0 | 123000 | 0 | 86800 | 0 | 8500 | 0 | 383550 | 0 | 140300 |
| 6 | 9 | 0 | 205930 | 0 | 232000 | 0 | 341070 | 0 | 4500 | 0 | 123000 | 2500 | 89300 | 0 | 8500 | 0 | 383550 | 0 | 140300 |
| 6 | 10 | 0 | 205930 | 0 | 232000 | 0 | 341070 | 0 | 4500 | 0 | 123000 | 3000 | 92300 | 0 | 8500 | 0 | 383550 | 0 | 140300 |
| 6 | 11 | 0 | 205930 | 0 | 232000 | 15000 | 356070 | 0 | 4500 | 0 | 123000 | 0 | 92300 | 0 | 8500 | 0 | 383550 | 0 | 140300 |
| 6 | 12 | 0 | 205930 | 2000 | 234000 | 0 | 356070 | 0 | 4500 | 0 | 123000 | 2000 | 94300 | 7300 | 15800 | 0 | 383550 | 0 | 140300 |
| 6 | 13 | 0 | 205930 | 0 | 234000 | 24000 | 380070 | 0 | 4500 | 0 | 123000 | 3000 | 97300 | 6000 | 21800 | 0 | 383550 | 0 | 140300 |
| 6 | 14 | 0 | 205930 | 3000 | 237000 | 0 | 380070 | 0 | 4500 | 0 | 123000 | 2000 | 99300 | 0 | 21800 | 15000 | 398550 | 0 | 140300 |
| 6 | 15 | 900 | 206830 | 5000 | 242000 | 0 | 380070 | 0 | 4500 | 0 | 123000 | 5000 | 104300 | 0 | 21800 | 0 | 398550 | 81000 | 221300 |
| 6 | 16 | 1600 | 208430 | 0 | 242000 | 0 | 380070 | 0 | 4500 | 0 | 123000 | 2000 | 106300 | 0 | 21800 | 0 | 398550 | 90000 | 311300 |
| 6 | 17 | 0 | 208430 | 0 | 242000 | 7000 | 387070 | 0 | 4500 | 0 | 123000 | 0 | 106300 | 0 | 21800 | 0 | 398550 | 6000 | 317300 |
| 6 | 18 | 0 | 208430 | 0 | 242000 | 2500 | 389570 | 0 | 4500 | 0 | 123000 | 0 | 106300 | 0 | 21800 | 0 | 398550 | 25000 | 342300 |
| 6 | 19 | 0 | 208430 | 0 | 242000 | 0 | 389570 | 6000 | 10500 | 0 | 123000 | 2000 | 108300 | 0 | 21800 | 0 | 398550 | 75600 | 417900 |
| 6 | 20 | 0 | 208430 | 0 | 242000 | 20000 | 409570 | 500 | 11000 | 0 | 123000 | 0 | 108300 | 0 | 21800 | 0 | 398550 | 59000 | 476900 |
| 6 | 21 | 0 | 208430 | 0 | 242000 | 20000 | 429570 | 1200 | 12200 | 0 | 123000 | 0 | 108300 | 0 | 21800 | 0 | 398550 | 3000 | 479900 |
| 6 | 22 | 0 | 208430 | 0 | 242000 | 0 | 429570 | 0 | 12200 | 0 | 123000 | 0 | 108300 | 3300 | 25100 | 0 | 398550 | 0 | 479900 |
| 6 | 23 | 0 | 208430 | 14000 | 256000 | 0 | 429570 | 0 | 12200 | 0 | 123000 | 0 | 108300 | 0 | 25100 | 0 | 398550 | 45000 | 524900 |
| 6 | 24 | 0 | 208430 | 0 | 256000 | 0 | 429570 | 0 | 12200 | 0 | 123000 | 500 | 108800 | 7000 | 32100 | 6000 | 404550 | 0 | 524900 |
| 6 | 25 | 0 | 208430 | 0 | 256000 | 0 | 429570 | 0 | 12200 | 0 | 123000 | 0 | 108800 | | | 0 | 404550 | 0 | 524900 |
| 6 | 26 | 0 | 208430 | 0 | 256000 | 10000 | 439570 | 0 | 12200 | 0 | 123000 | 0 | 108800 | | | 0 | 404550 | 0 | 524900 |
| 6 | 27 | 4900 | 213330 | 0 | 256000 | 0 | 439570 | 0 | 12200 | 0 | 123000 | 0 | 108800 | | | 0 | 404550 | 0 | 524900 |
| 6 | 28 | 14000 | 227330 | 0 | 256000 | 0 | 439570 | 0 | 12200 | 0 | 123000 | 0 | 108800 | | | 0 | 404550 | 0 | 524900 |
| 6 | 29 | 7500 | 234830 | 0 | 256000 | 0 | 439570 | 0 | 12200 | 0 | 123000 | 200 | 109000 | | | 0 | 404550 | 0 | 524900 |
| 6 | 30 | 0 | 234830 | 0 | 256000 | 0 | 439570 | 5000 | 17200 | 0 | 123000 | | | | | 0 | 404550 | 5000 | 529900 |

Table 8 (cont).

| | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Day | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. | Catch | Cumul. |
| 7 | 1 | 0 | 234830 | 0 | 256000 | 0 | 439570 | 6500 | 23700 | 0 | 123000 | | | | | 13600 | 418150 | 8000 | 537900 |
| 7 | 2 | 0 | 234830 | 4300 | 260300 | 5000 | 444570 | 0 | 23700 | 0 | 123000 | | | | | | | 4500 | 542400 |
| 7 | 3 | 0 | 234830 | | | | | 0 | 23700 | 15000 | 138000 | | | | | | | 2400 | 544800 |
| 7 | 4 | 1750 | 236580 | | | | | 0 | 23700 | 3000 | 141000 | | | | | | | 0 | 544800 |
| 7 | 5 | | | | | | | 0 | 23700 | 1500 | 142500 | | | | | | | 4000 | 548800 |
| 7 | 6 | | | | | | | 14000 | 37700 | 0 | 142500 | | | | | | | | |
| 7 | 7 | | | | | | | 3000 | 40700 | 0 | 142500 | | | | | | | | |
| 7 | 8 | | | | | | | 0 | 40700 | 6000 | 148500 | | | | | | | | |
| 7 | 9 | | | | | | | 0 | 40700 | 0 | 148500 | | | | | | | | |
| 7 | 10 | | | | | | | 0 | 40700 | 0 | 148500 | | | | | | | | |
| 7 | 11 | | | | | | | 6000 | 46700 | 0 | 148500 | | | | | | | | |
| 7 | 12 | | | | | | | 0 | 46700 | 0 | 148500 | | | | | | | | |
| 7 | 13 | | | | | | | 0 | 46700 | 0 | 148500 | | | | | | | | |
| 7 | 14 | | | | | | | 2000 | 48700 | 0 | 148500 | | | | | | | | |
| 7 | 15 | | | | | | | 0 | 48700 | 1000 | 149500 | | | | | | | | |
| 7 | 16 | | | | | | | 0 | 48700 | | | | | | | | | | |
| 7 | 17 | | | | | | | 0 | 48700 | | | | | | | | | | |
| 7 | 18 | | | | | | | 0 | 48700 | | | | | | | | | | |
| 7 | 19 | | | | | | | 0 | 48700 | | | | | | | | | | |
| 7 | 20 | | | | | | | 0 | 48700 | | | | | | | | | | |
| 7 | 21 | | | | | | | 3000 | 51700 | | | | | | | | | | |
| Total | | 236580 | | 260300 | | 444570 | | 51700 | | 149500 | | 109000 | | 32100 | | 418150 | | 548800 | |



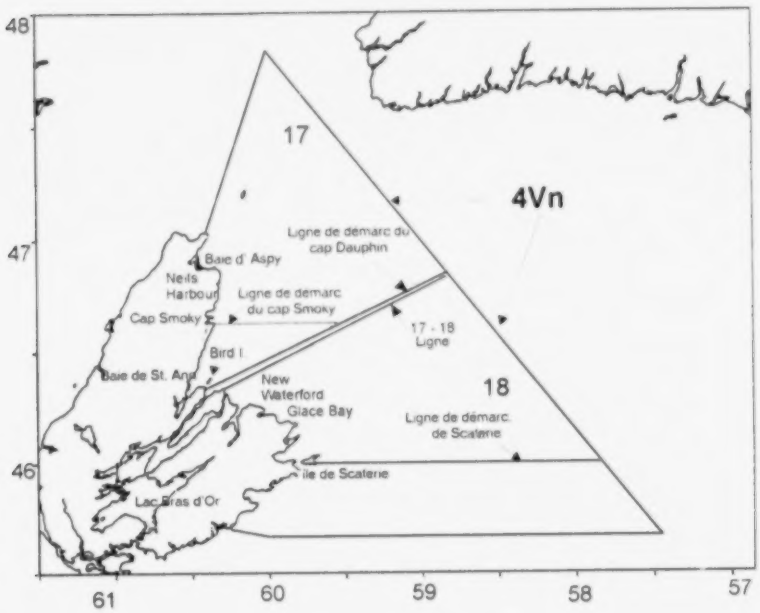




Fig. 1. Place names and management lines indicated in text.

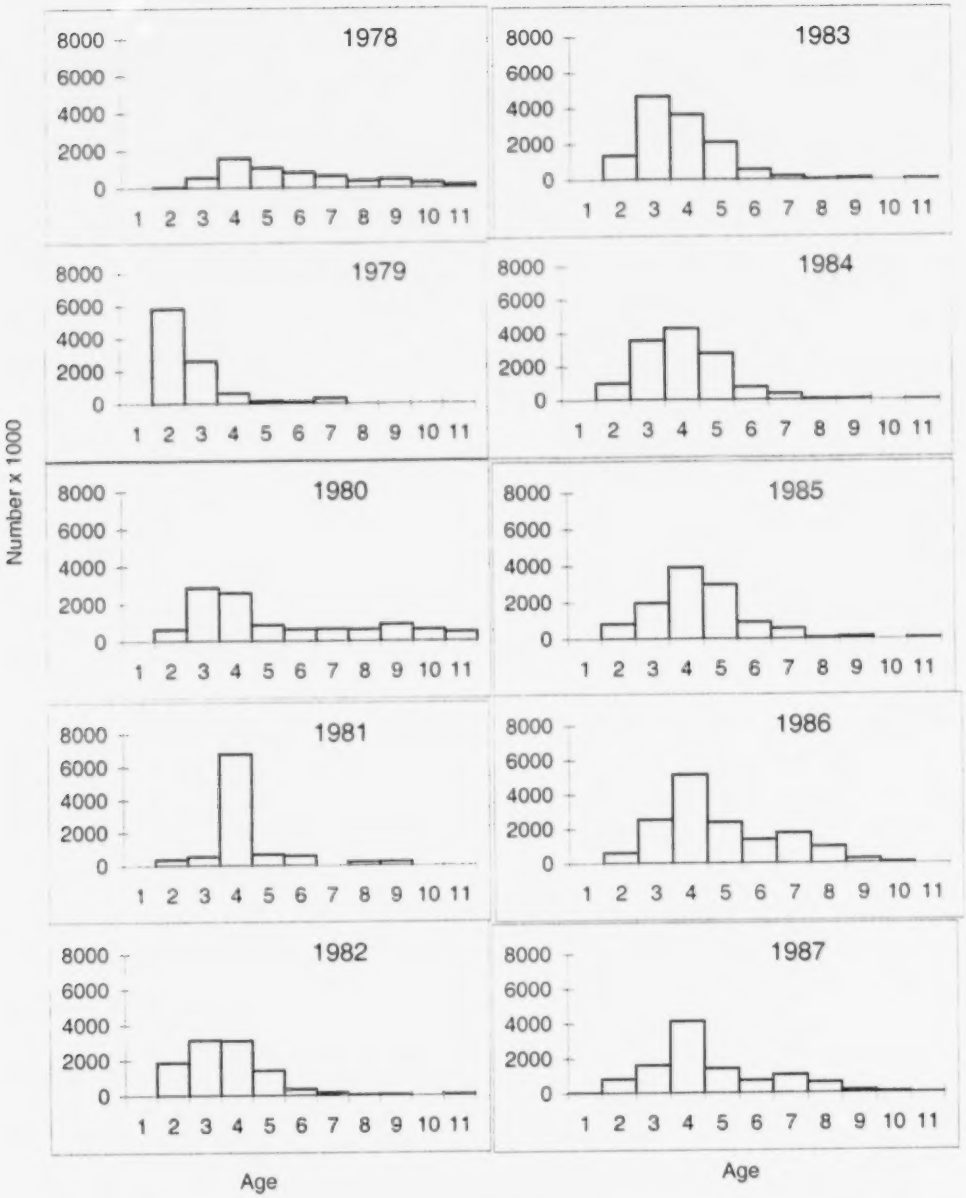



Fig. 2. Fall spawner catch at age for large seiners in 4Vn.

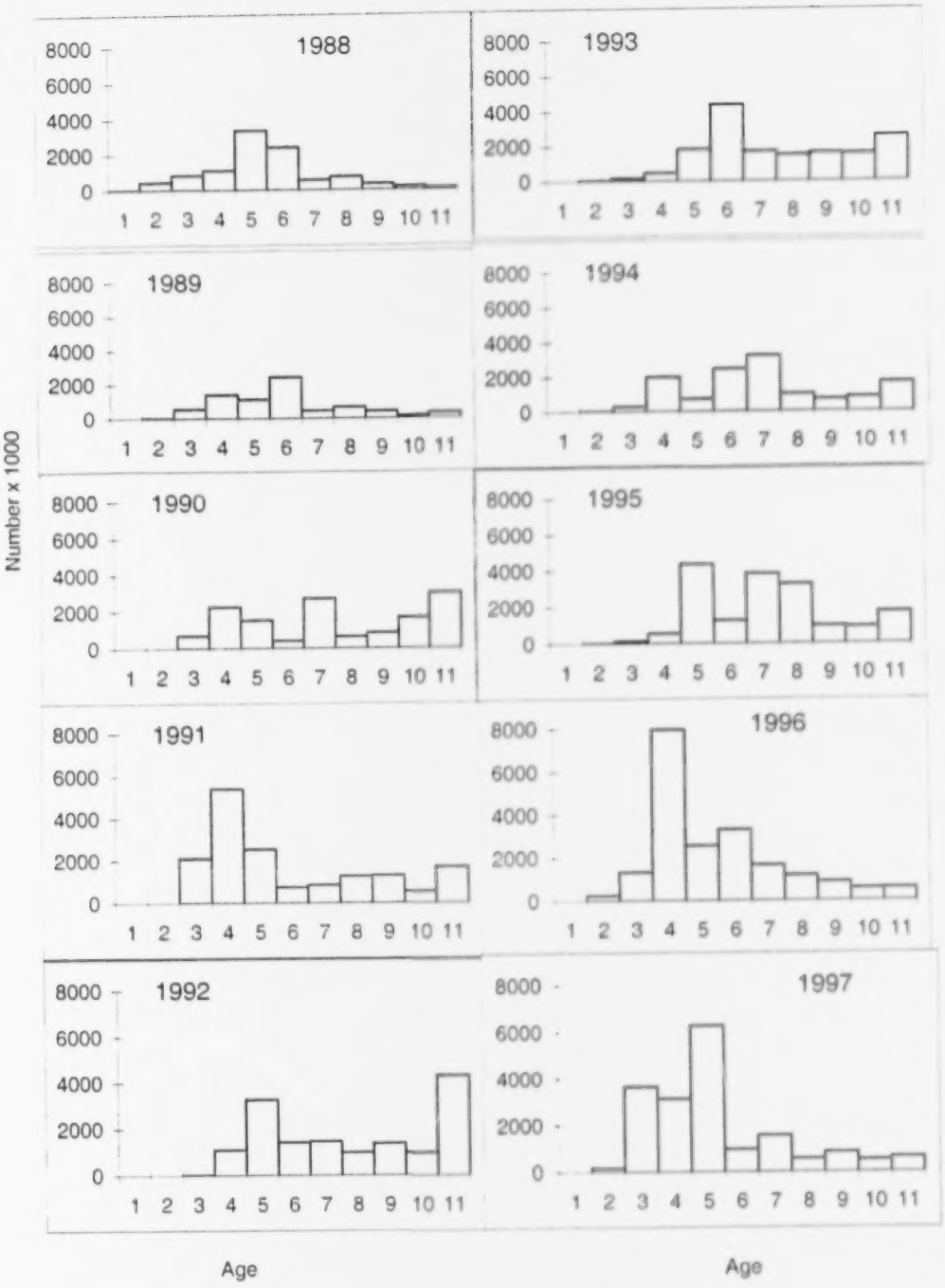



Fig. 2 (cont). Fall spawner catch at age for large seiners in 4Vn.

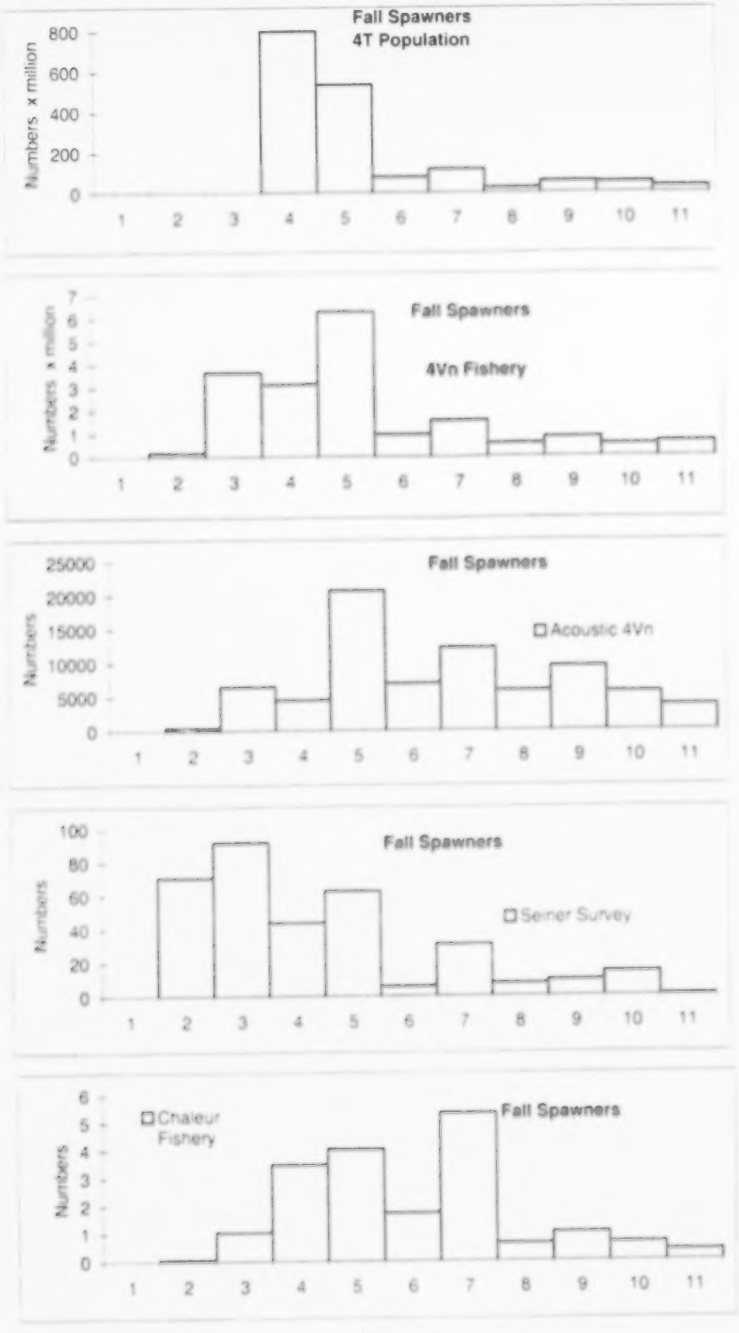



Fig. 3. Age structure from 1997 fishery and survey sampling in 4T and 4Vn for fall spawners.

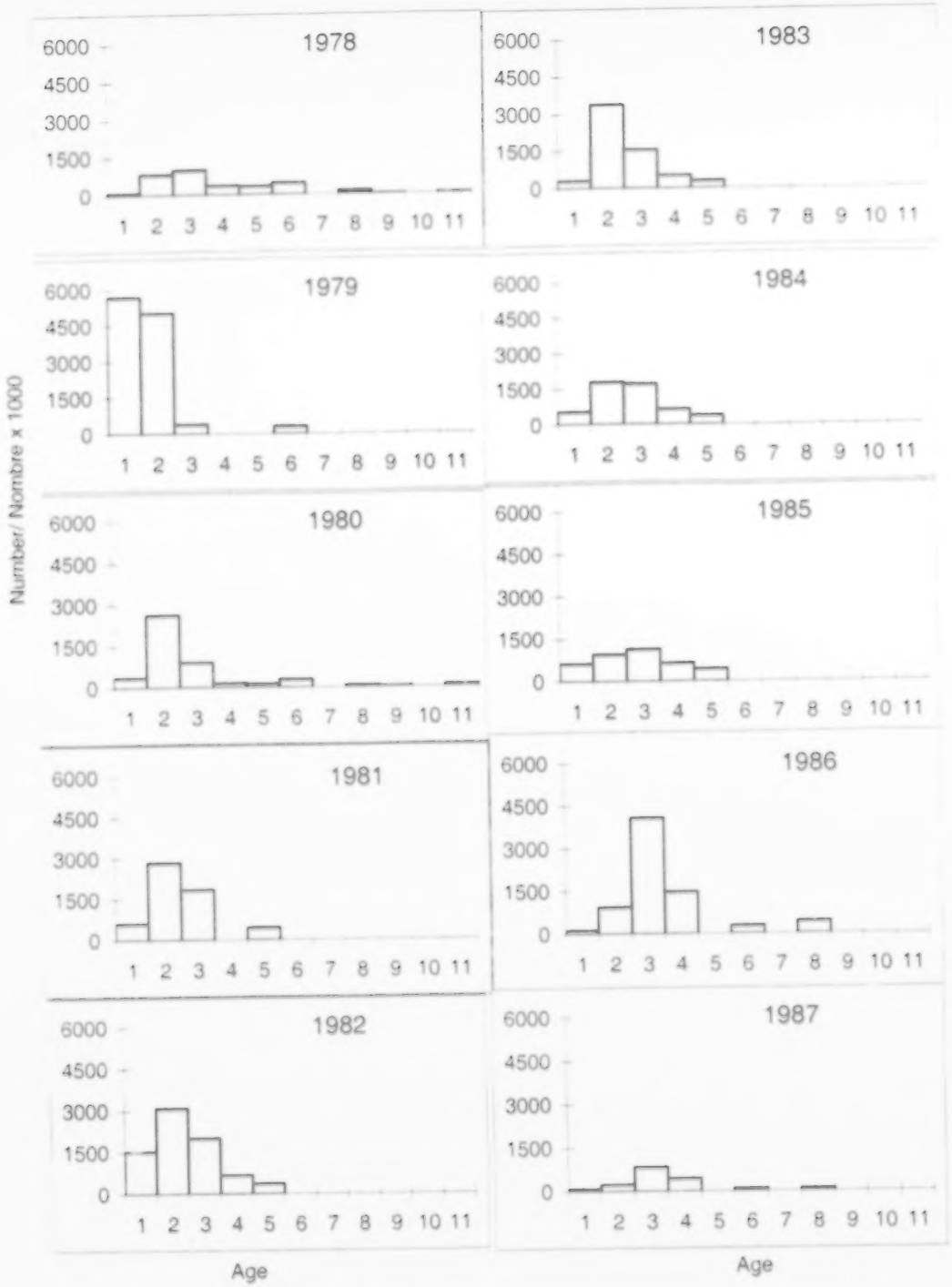



Fig. 4. Spring spawner 1997 catch at age for large seiners in 4Vn.

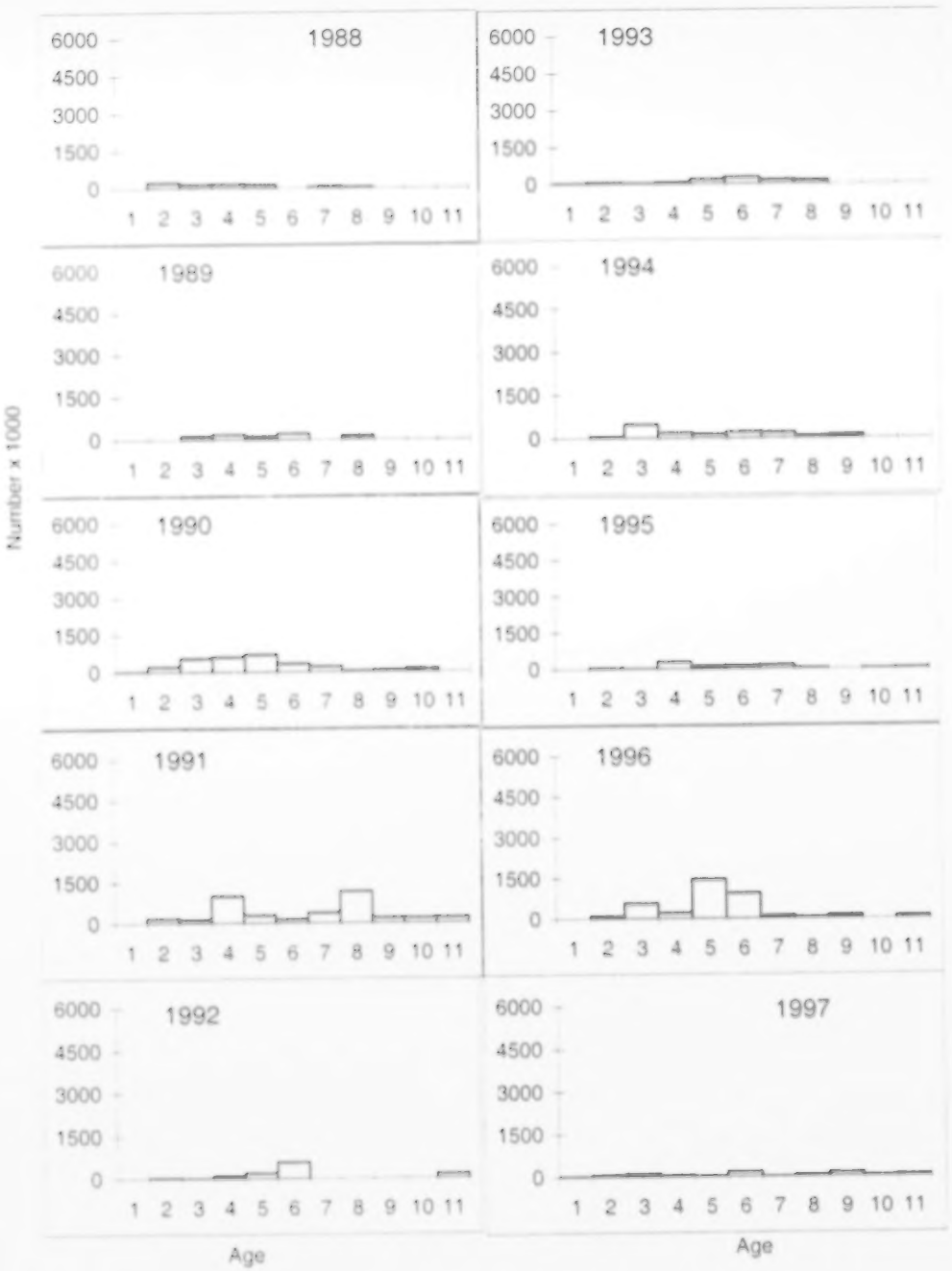



Fig. 4. (cont). Spring spawner 1997 catch at age for large seiners in 4Vn.

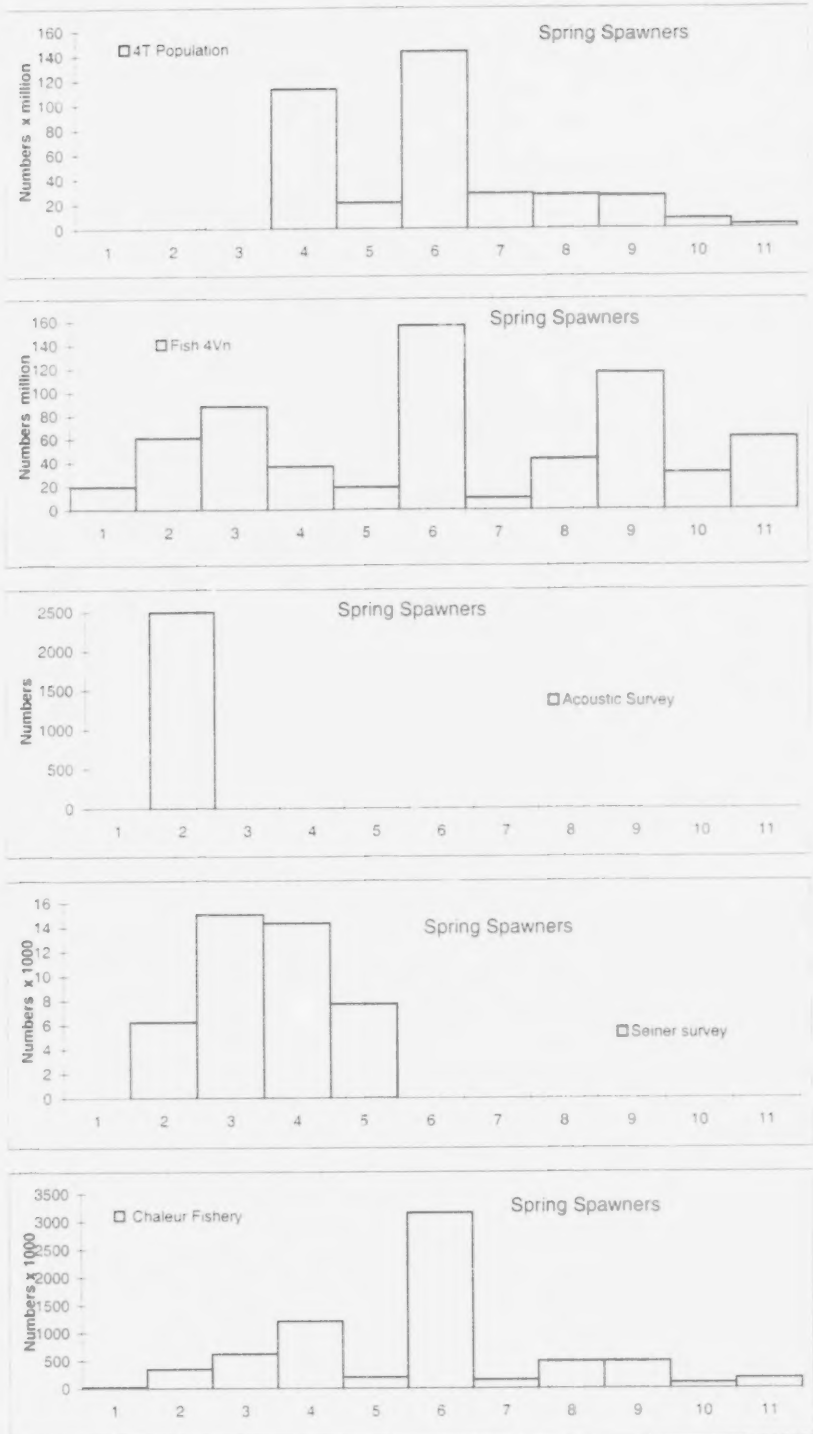



Fig. 5. Age structure for spring spawners from 1997 4T and 4Vn fisheries and surveys.

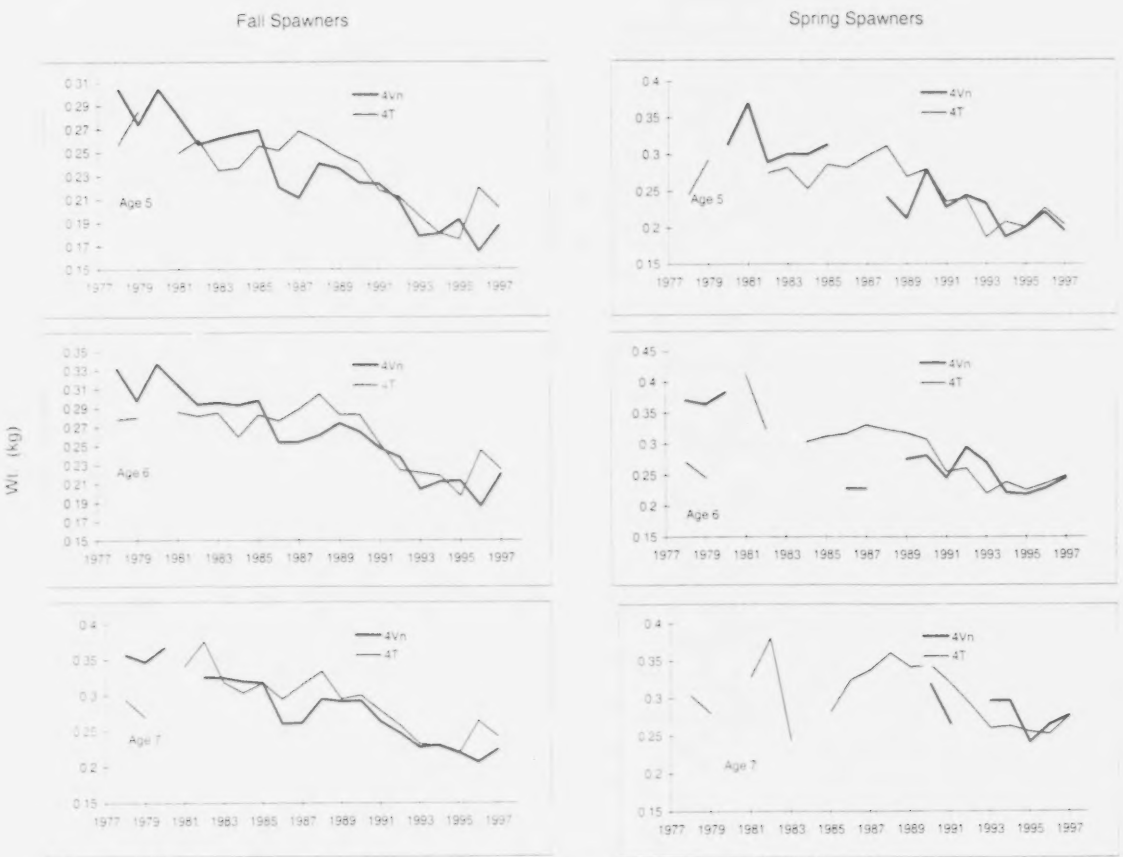



Fig 6. Mean weights for ages 5 to 7 for fall and spring spawners caught by seiners in 4T and 4Vn.

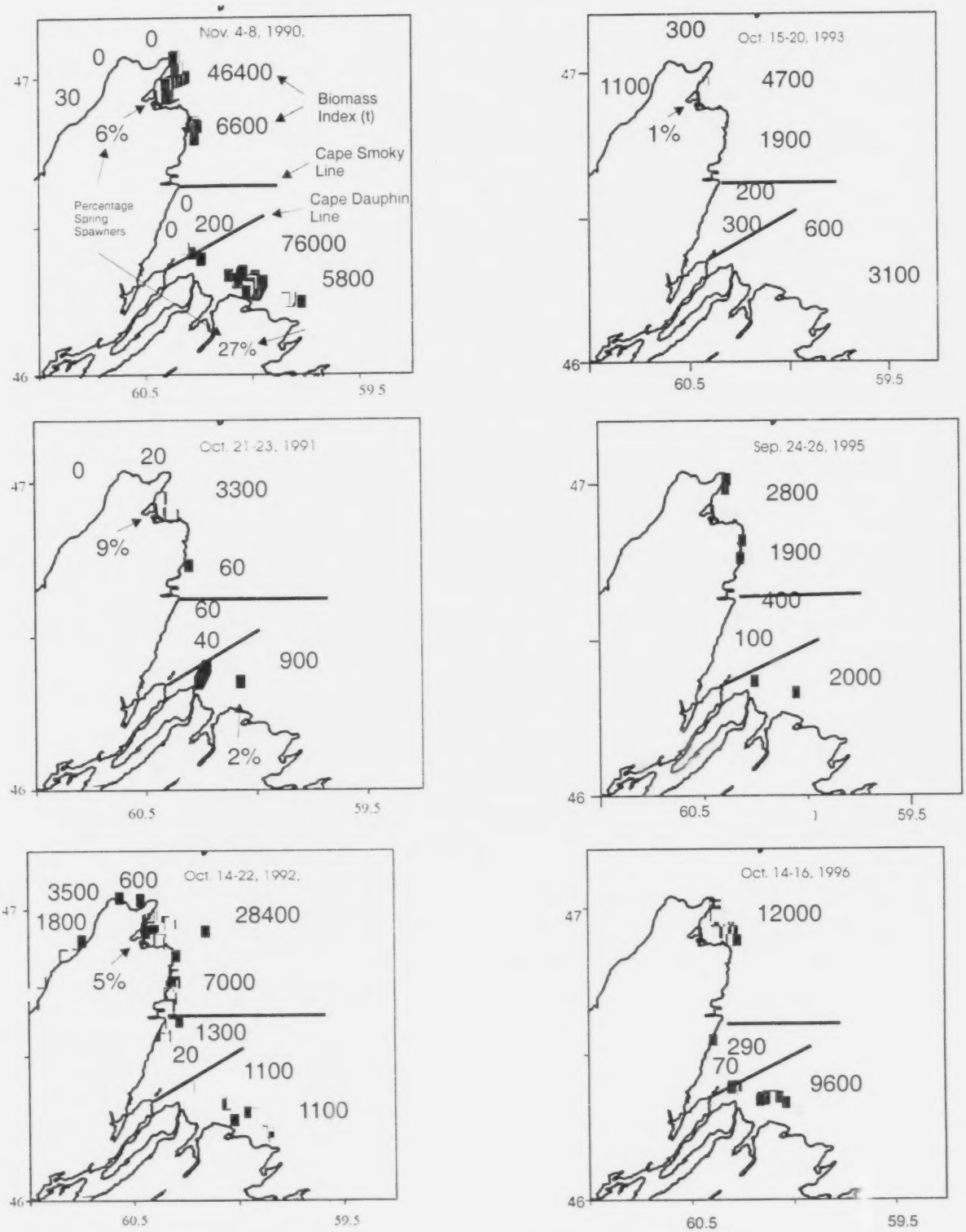



Fig. 7. Biomass indices in tonnes (rounded numbers) estimated during acoustic surveys in 4Vn from 1990-93, and 1995-96. Percentages are for spring spawners in indicated areas. Gray scale indicates relative density with darkest being most dense. There was no survey in 4Vn in 1994.

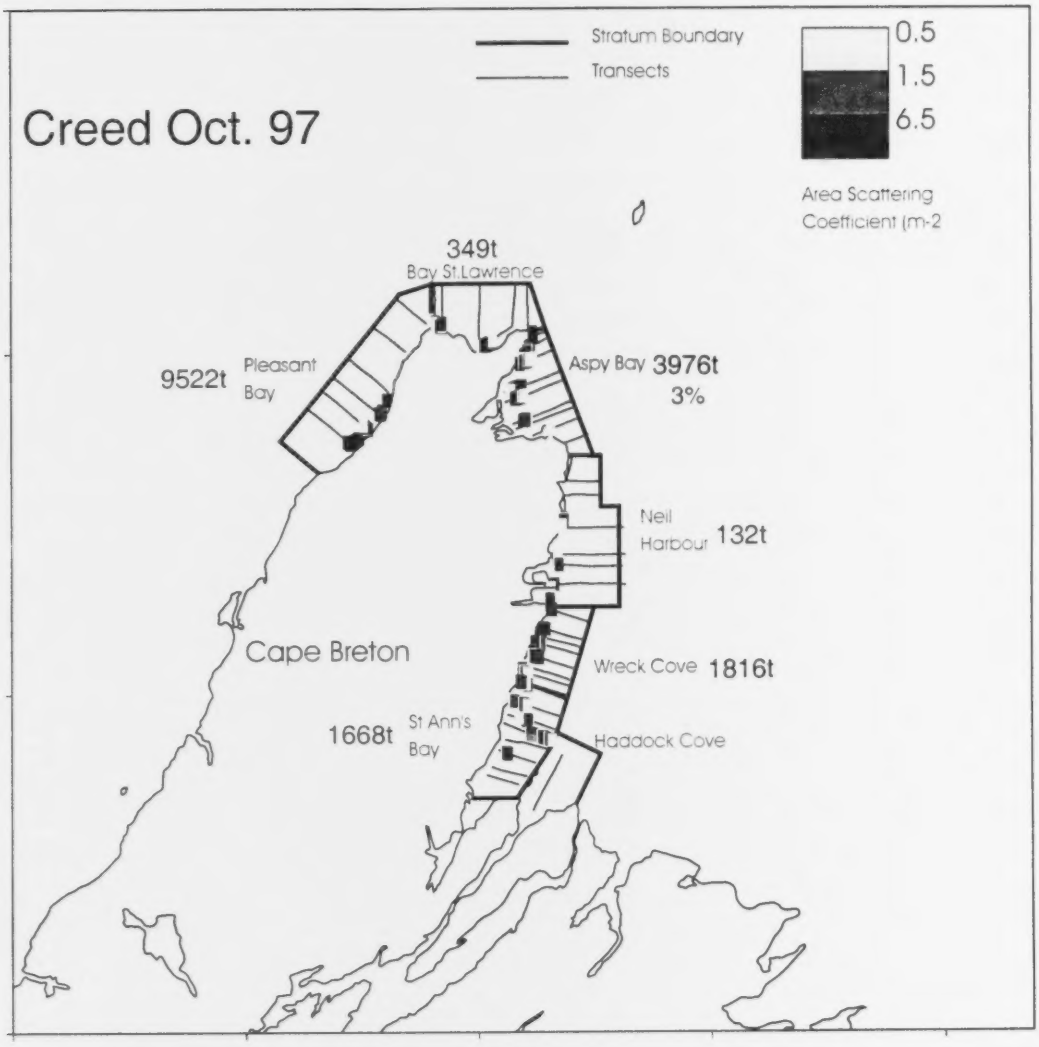



Fig. 8. Cape Breton area stratum and acoustic transect locations, with relative backscatter detected between Oct. 8 and 11, 1997. Percentages are for spring spawenrs in indicated areas.

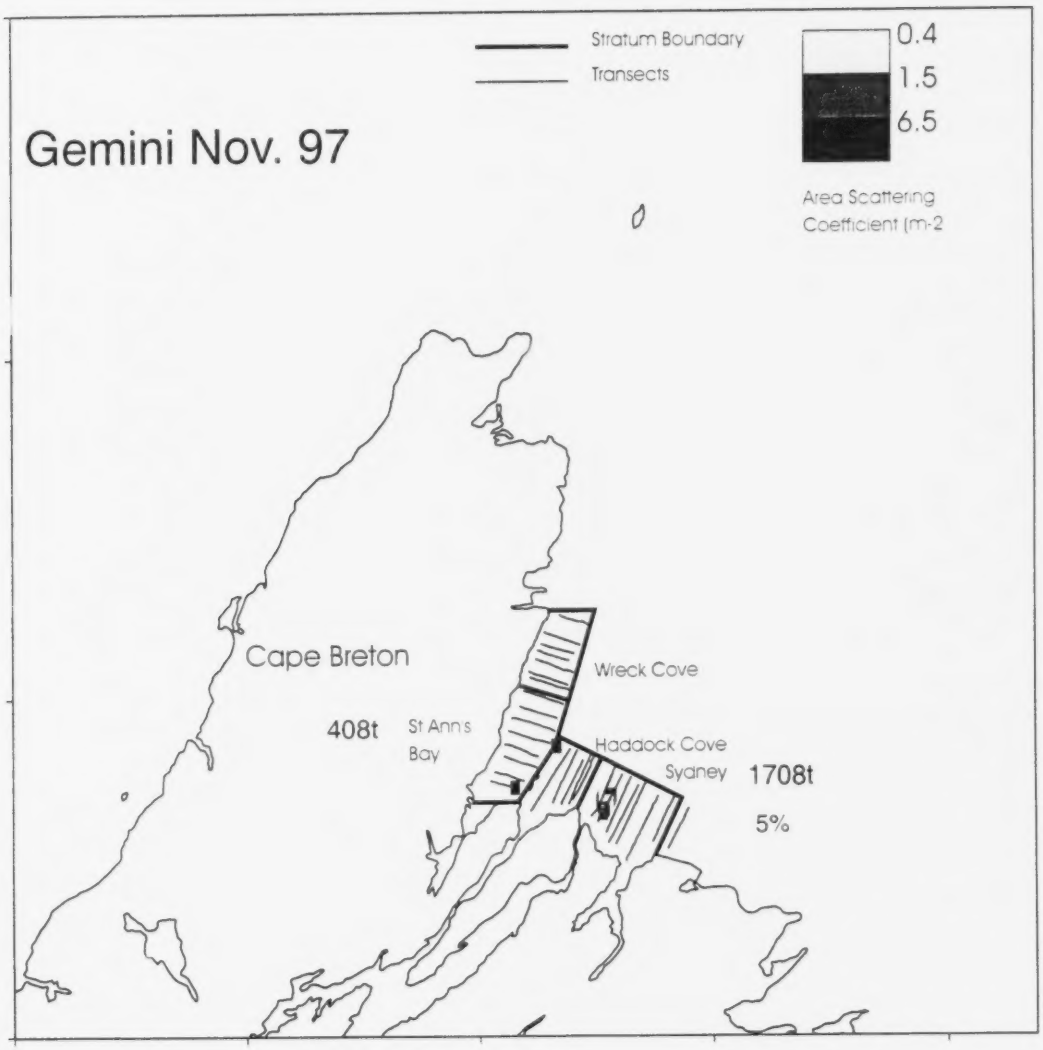



Fig. 9. Gemini survey, Cape Breton area stratum and acoustic transect locations, with relative backscatter detected between Nov. 21 -26, 1997. Percentages are for spring spawenrs in indicated areas.

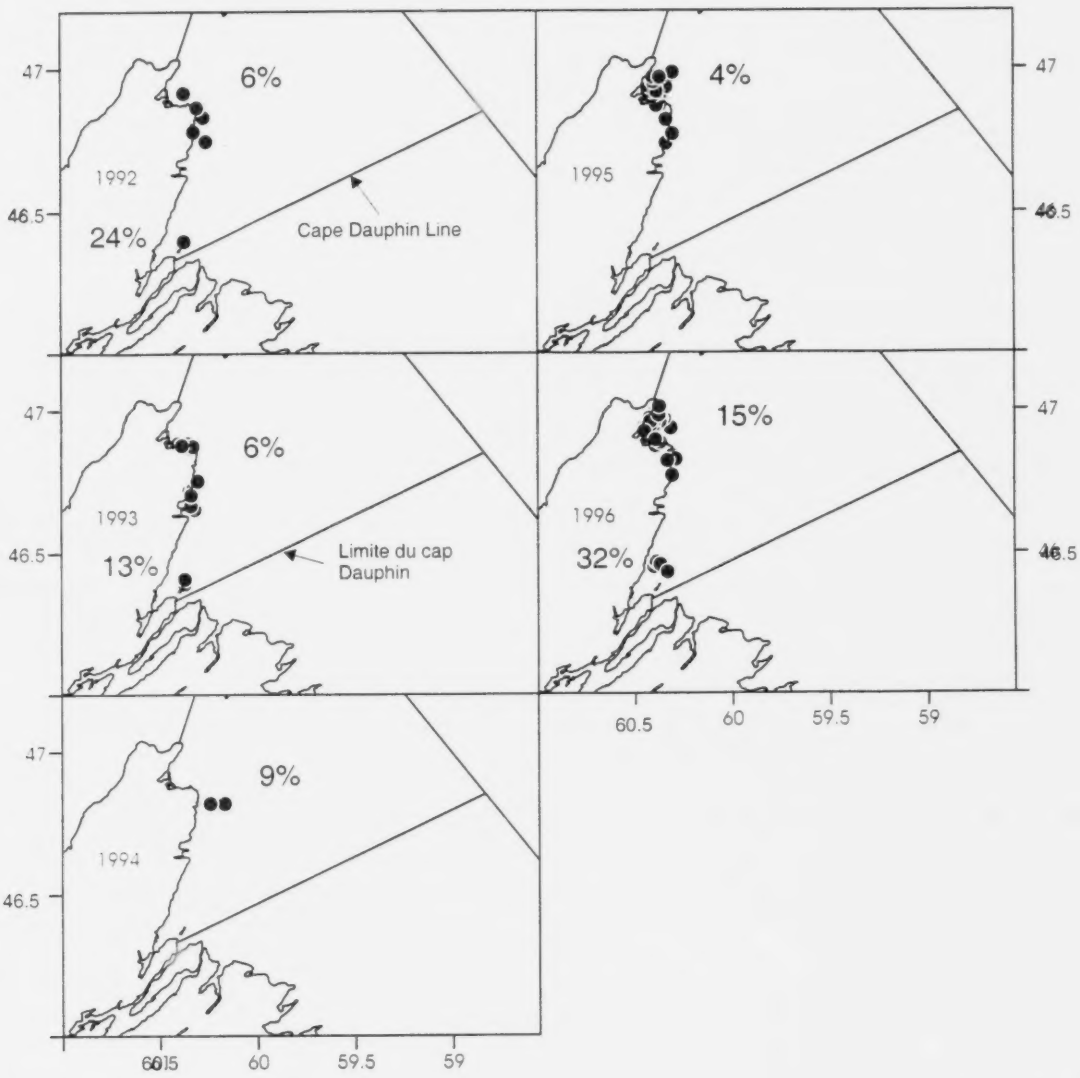



Fig.10. Location of purse seine samples from 1992 to 1996. The percentages refer to spring spawners in the indicated areas.

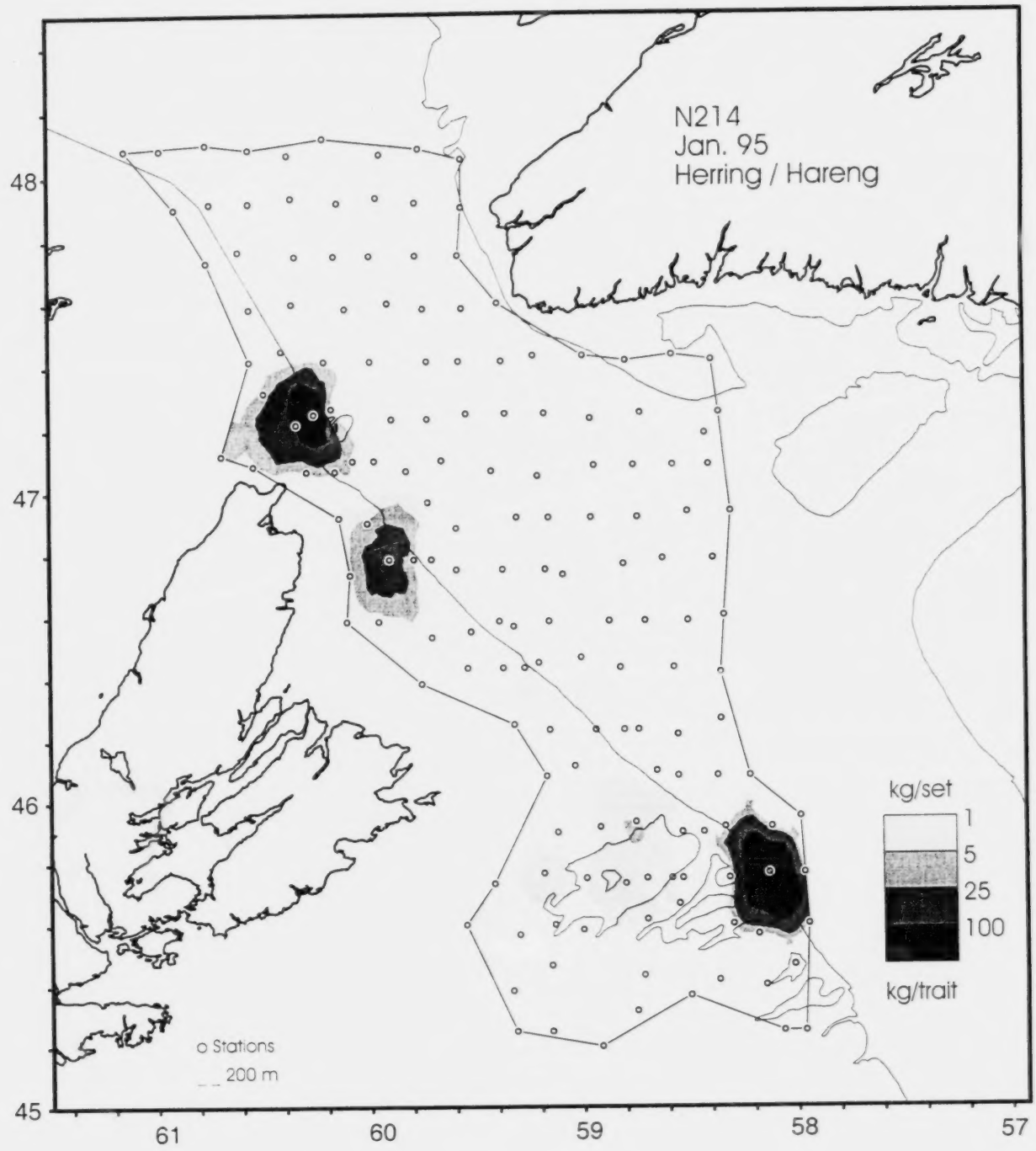



Fig. 11. Distribution of herring during the January 1995 bottom trawl survey in 4Vn.

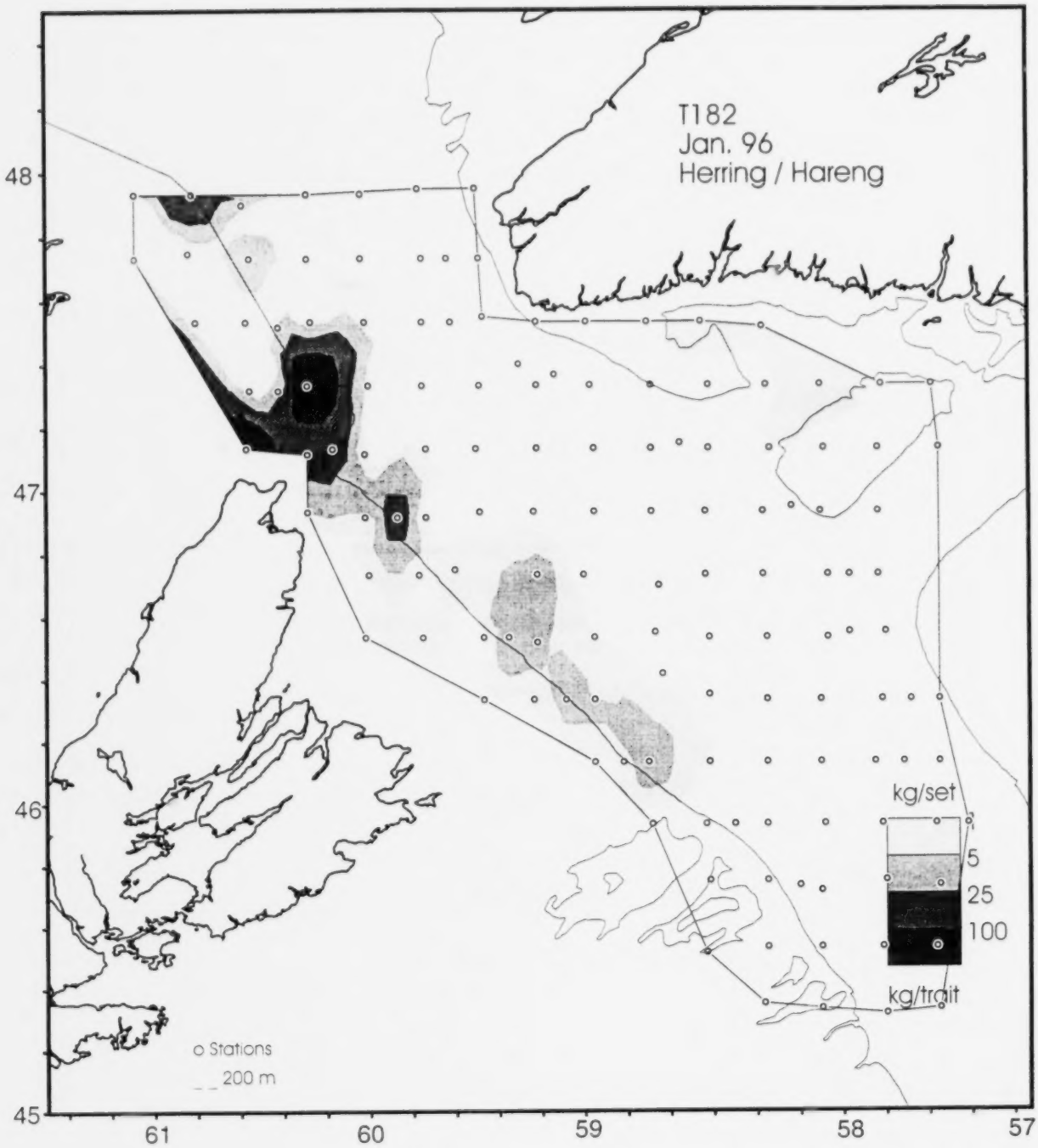



Fig. 12. Distribution of herring during the January 1996 bottom trawl survey in 4Vn.

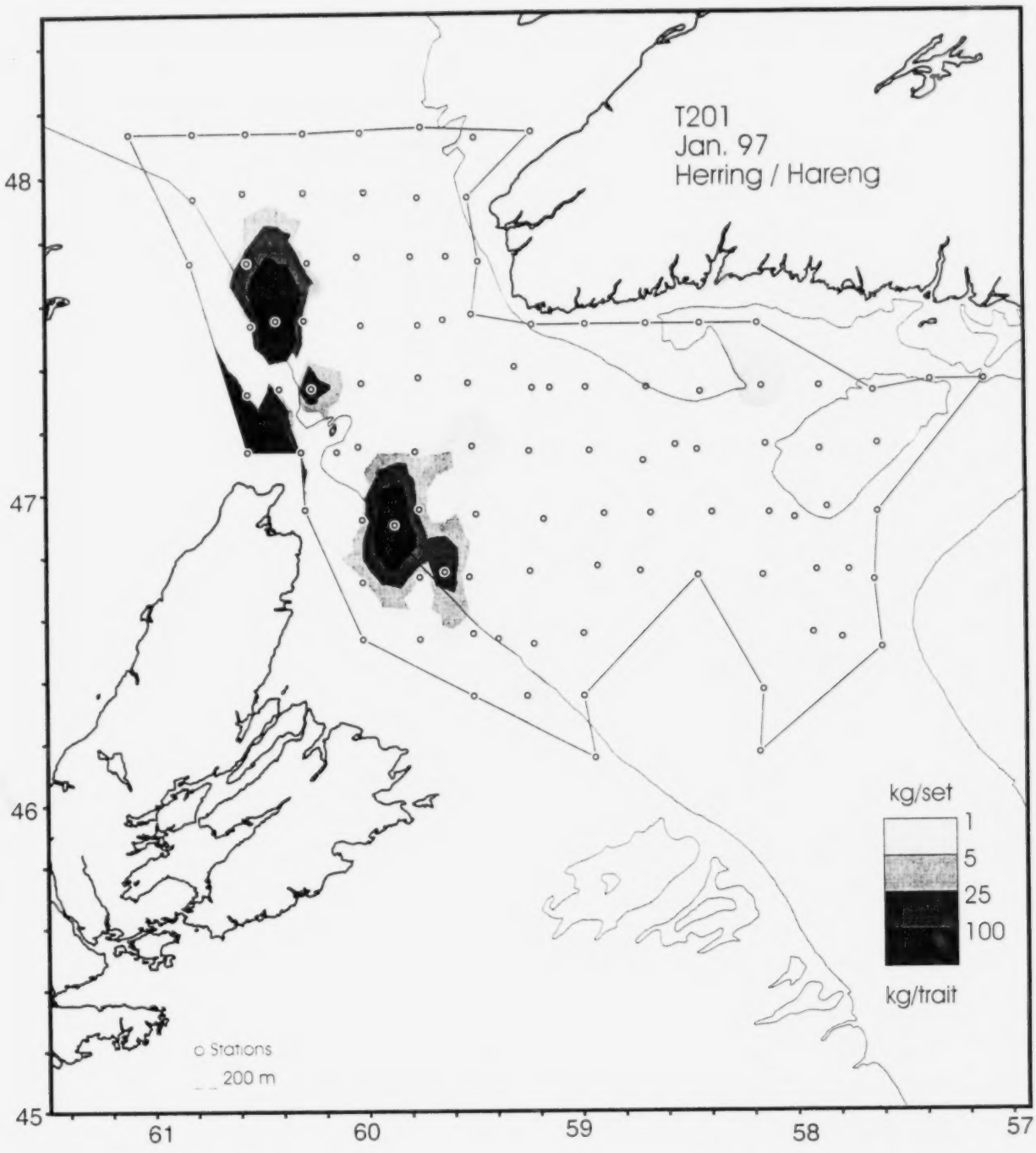



Fig. 13. Distribution of herring during the January 1997 bottom trawl survey in 4Vn.

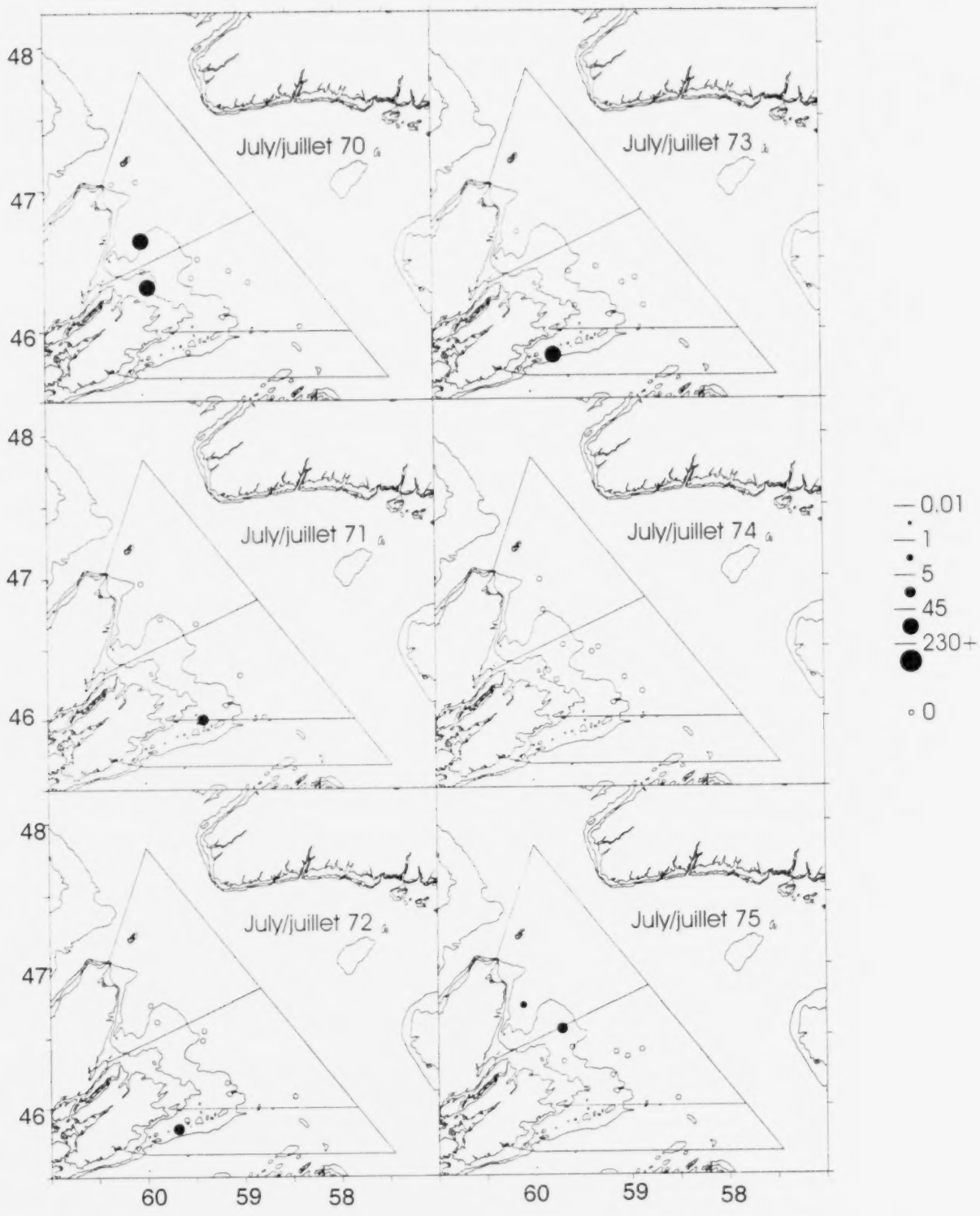



Fig. 14. Distribution of herring during July bottom trawl surveys in 4Vn, 1970-75. Offshore lines are 50 and 100 m depth contours. Units are kg/standard tow. Cape Dauphin and Scaterie Lines are as in Fig. 1.

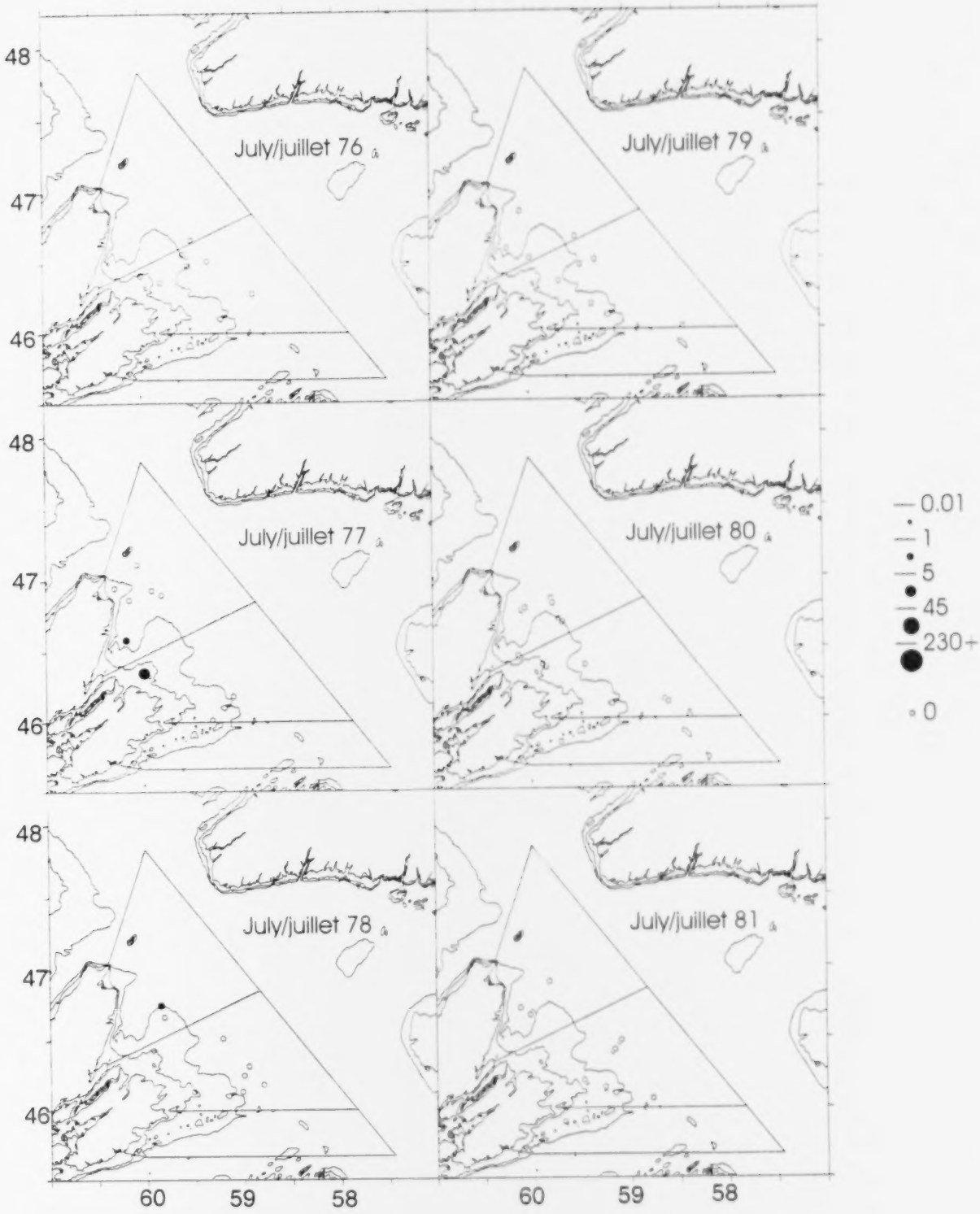



Fig. 15. Distribution of herring during July bottom trawl surveys in 4Vn, 1976-81. Offshore lines are 50 and 100 m depth contours. Units are kg/standard tow. Cape Dauphin and Scateries Lines are as in Fig. 1.

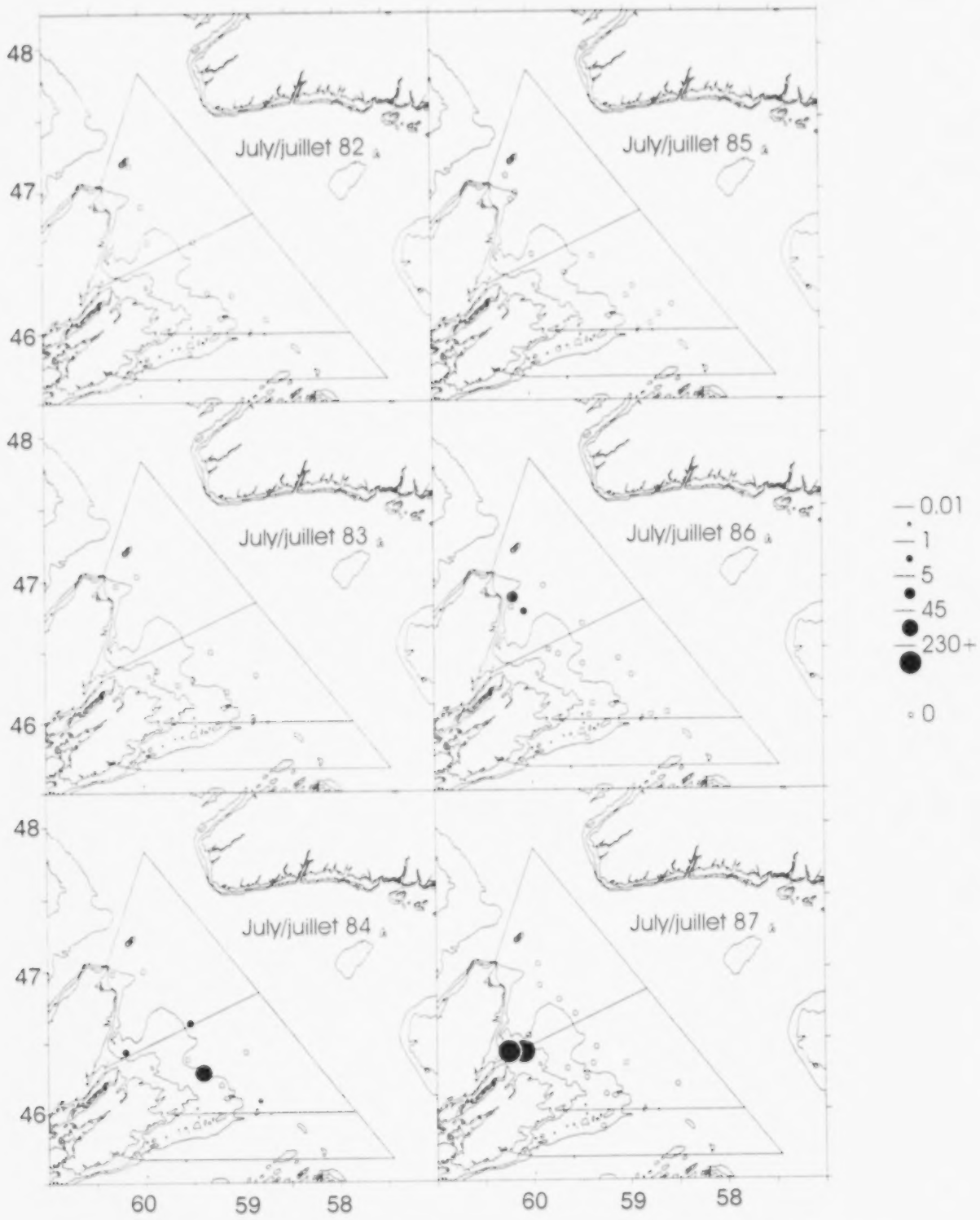



Fig. 16. Distribution of herring during July bottom trawl surveys in 4Vn, 1976-81. Offshore lines are 50 and 100 m depth contours. Units are kg/standard tow. Cape Dauphin and Scaterie Lines are as in Fig. 1.

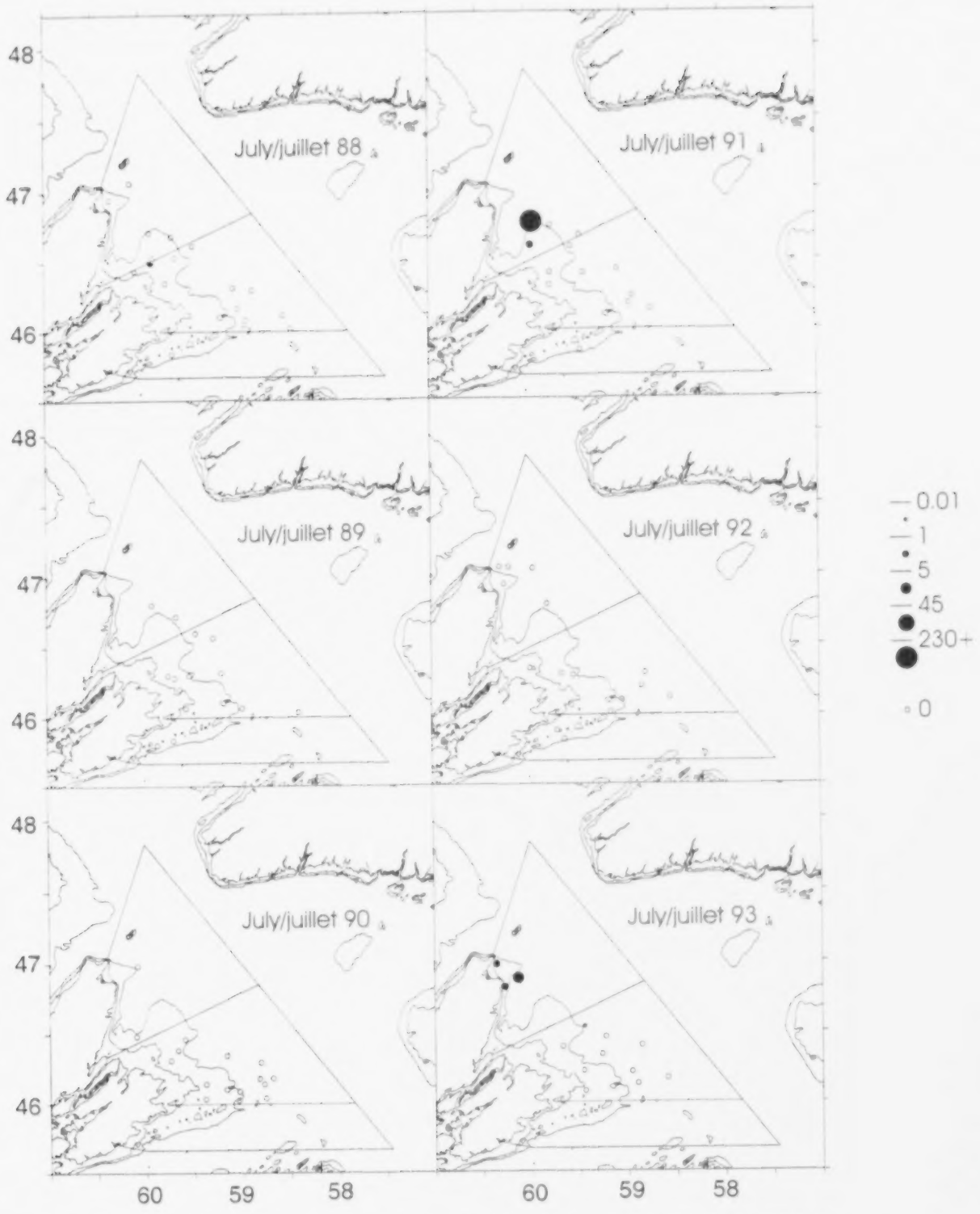



Fig. 17. Distribution of herring during July bottom trawl surveys in 4Vn, 1976-81. Offshore lines are 50 and 100 m depth contours. Units are kg/standard tow. Cape Dauphin and Scaterie Lines are as in Fig. 1.

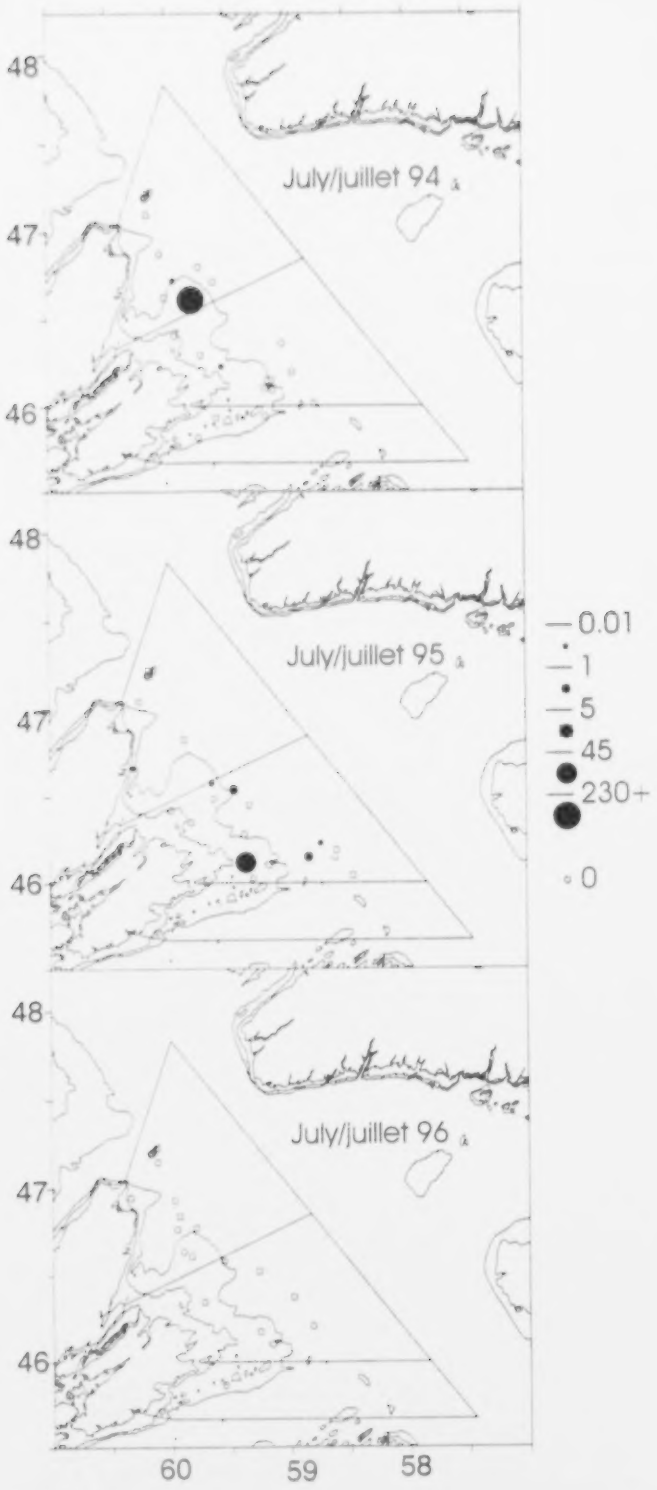



Fig. 18. Distribution of herring during July bottom trawl surveys in 4Vn, 1994-96. Offshore lines are 50 and 100 m depth contours. Units are kg/standard tow. Cape Dauphin and Scaterie Lines are as in Fig. 1.

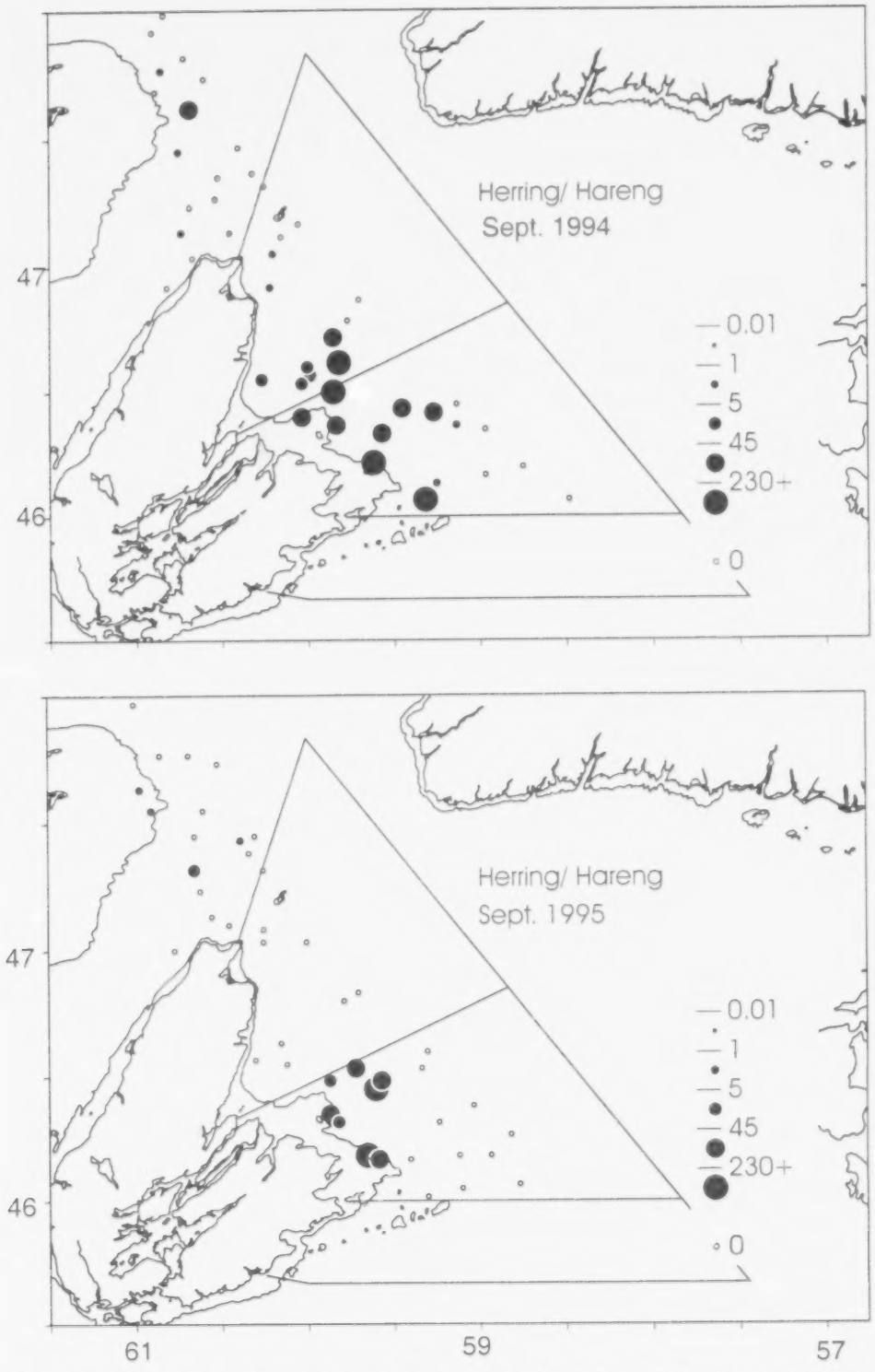



Fig. 19. Herring kg/standard tow from September bottom trawl surveys in 4Vn. Cape Dauphin and Scaterie Lines as in Fig. 1. Offshore line is 50 m depth contour.

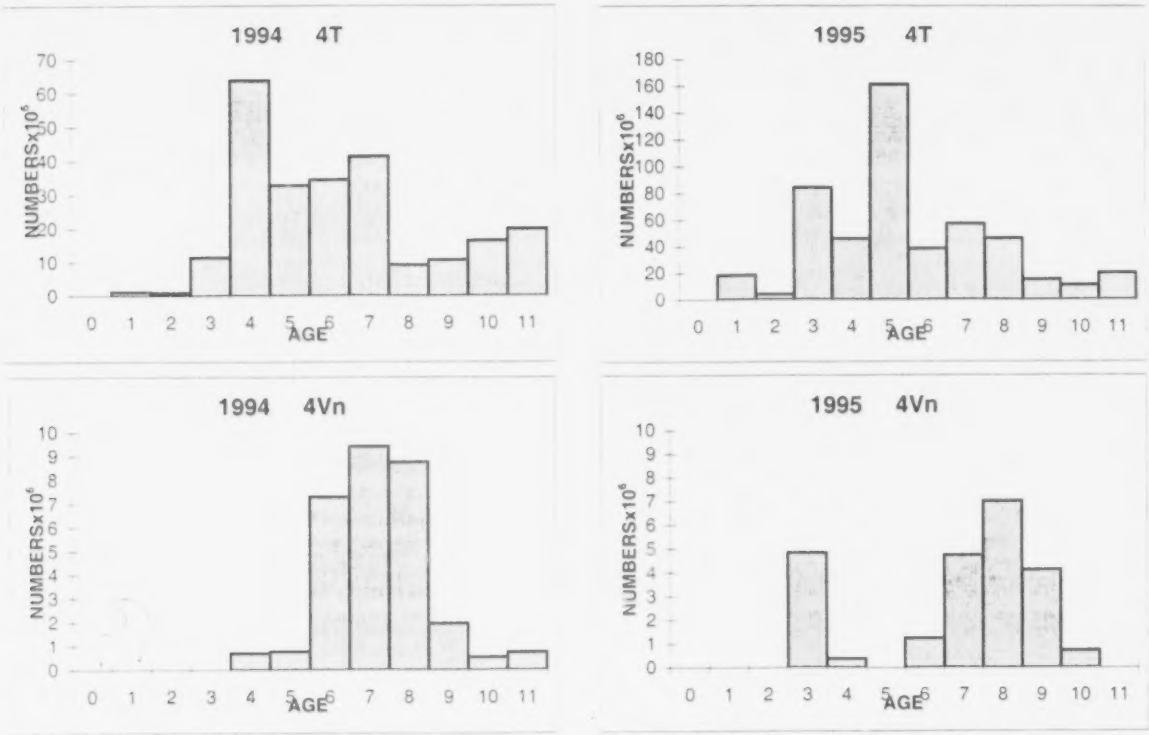



Fig. 20. Comparison of fall spawner age structure from bottom trawl surveys in 1994 and 1995 in 4Vn and 4T.

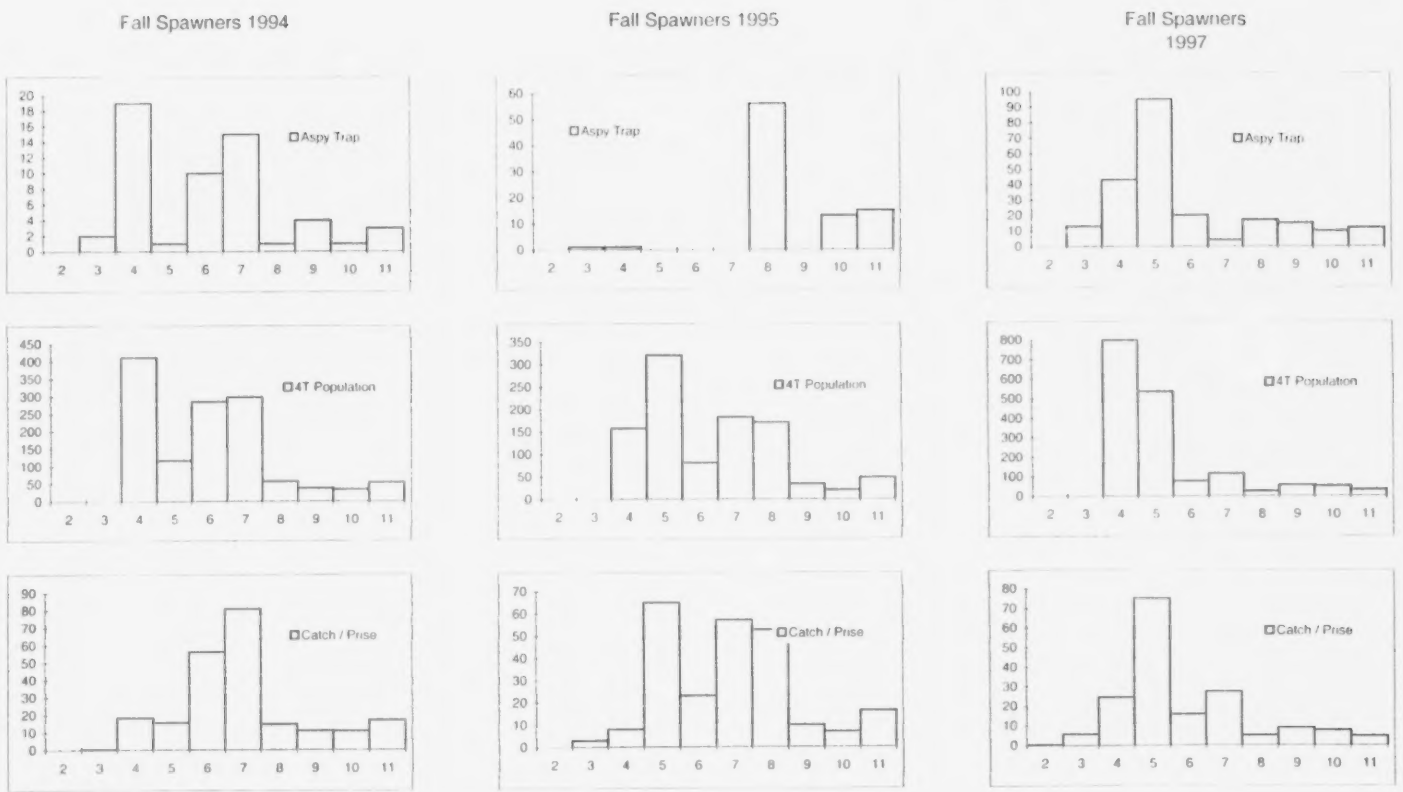



Fig 21 Comparison of fall spawner age structure in Aspy Bay trapnet during spring fishery, 4T fall spawner population, and 4T fall spawner catch all gears

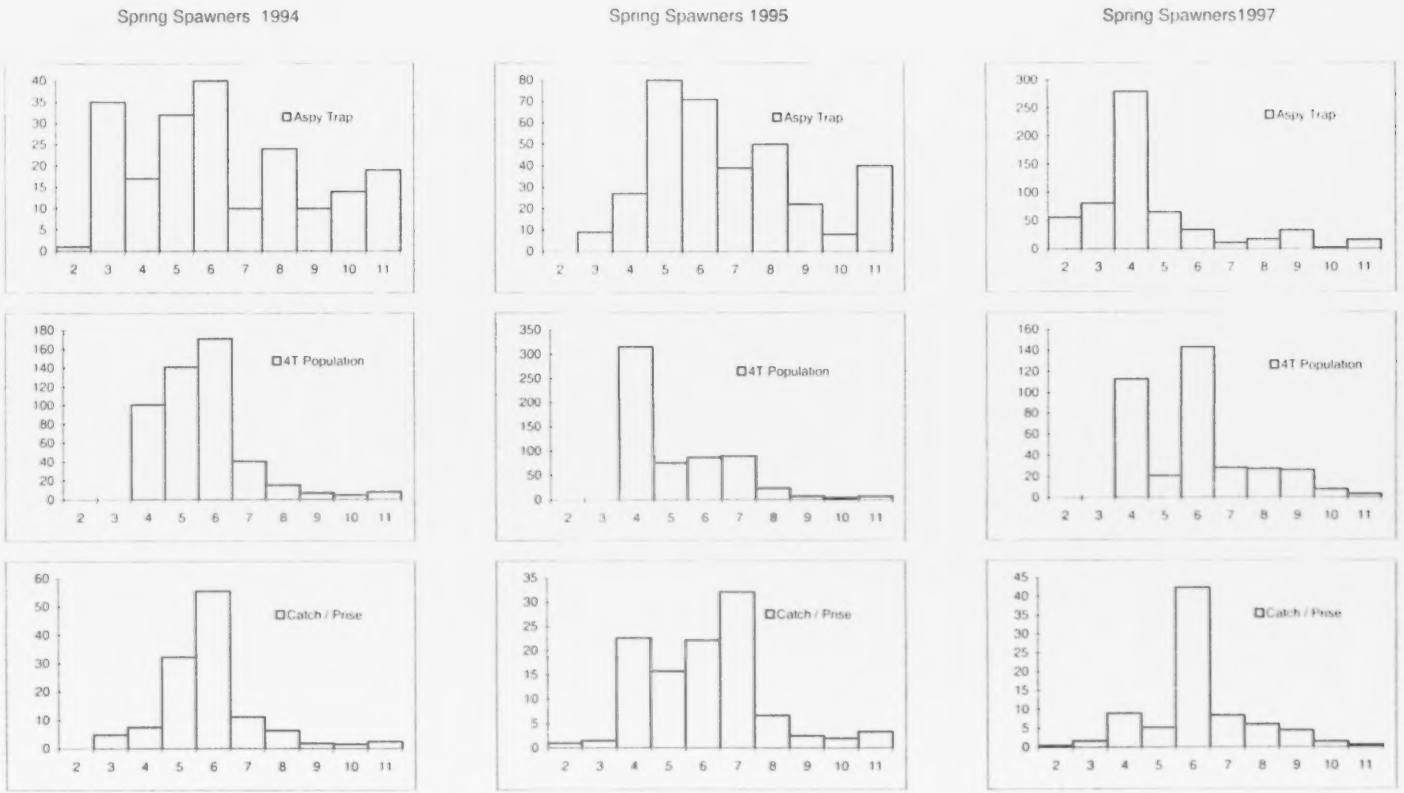



Fig 22. Comparison of spring spawner age structure in Aspy Bay trapnet during spring fishery, 4T spring spawner population, and 4T spring spawner catch all gears

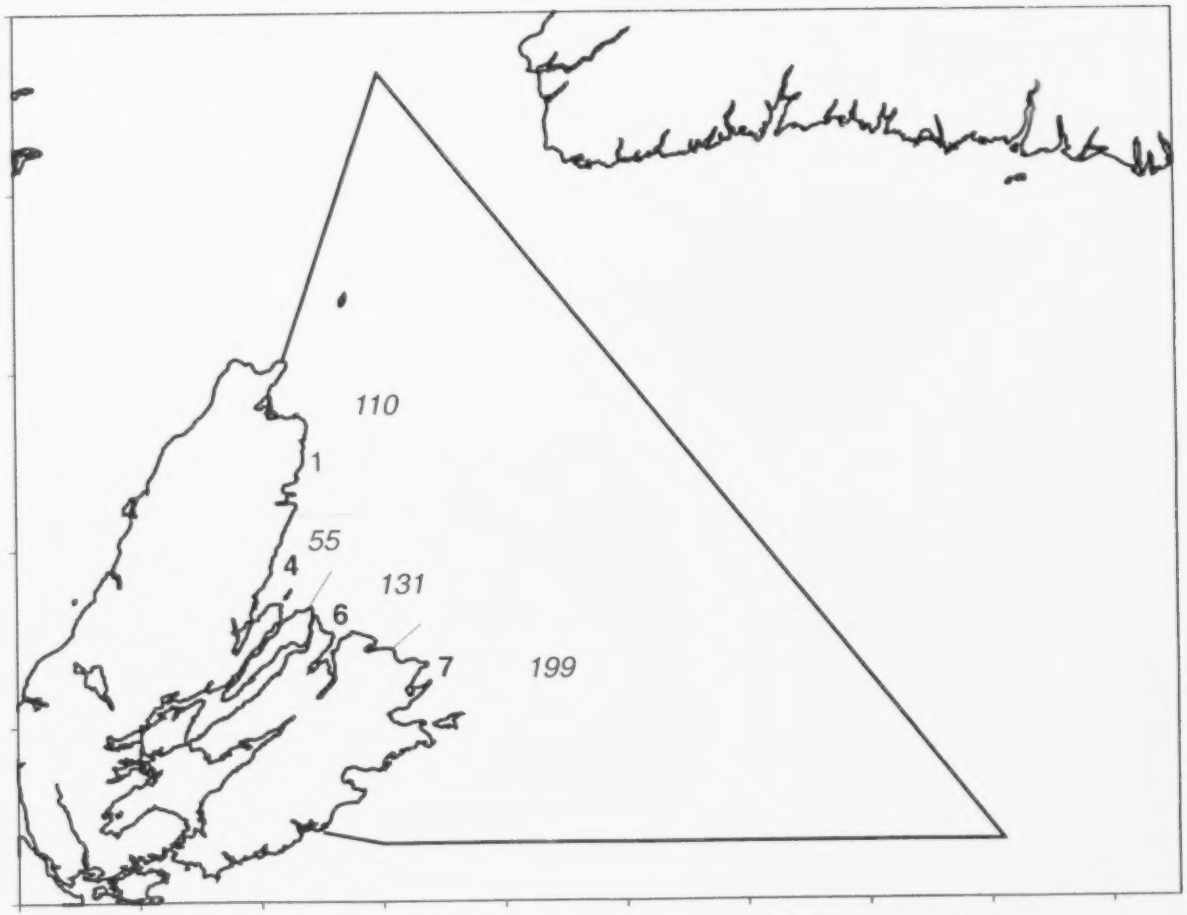



Fig. 23. Number of lobster licenses (italics) in each statistical district (bold).

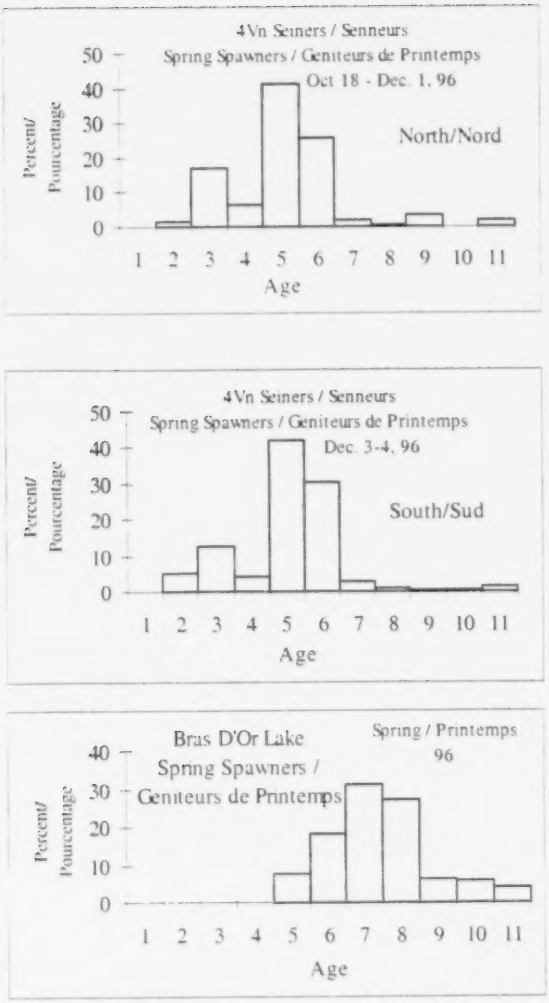



Fig. 24. Comparison of age structure for spring spawners caught in the seiner fishery in the northern part of the fishery (north of Cape Smoky), southern part of the fishery (St. Ann's Bay), and Bras d'Or lake gillnet fishery in 1996.

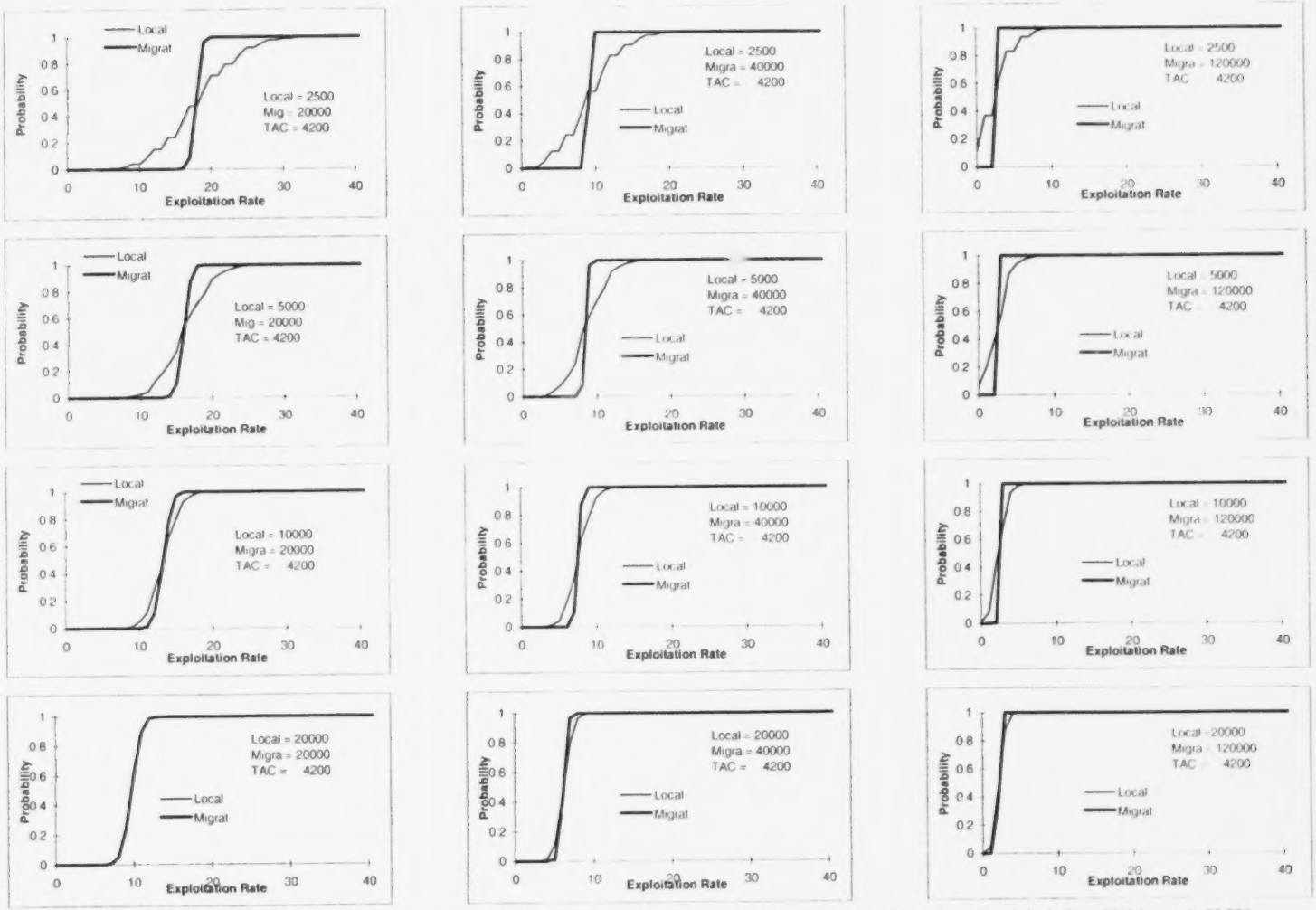



Fig. 25. Results of simulations investigating the exploitation rates expected by keeping the TAC constant at 4200 tonnes and varying the size of local stocks from 2500 tonnes to 20,000 tonnes and migrating stocks from 20,000 tonnes to 120,000 tonnes.

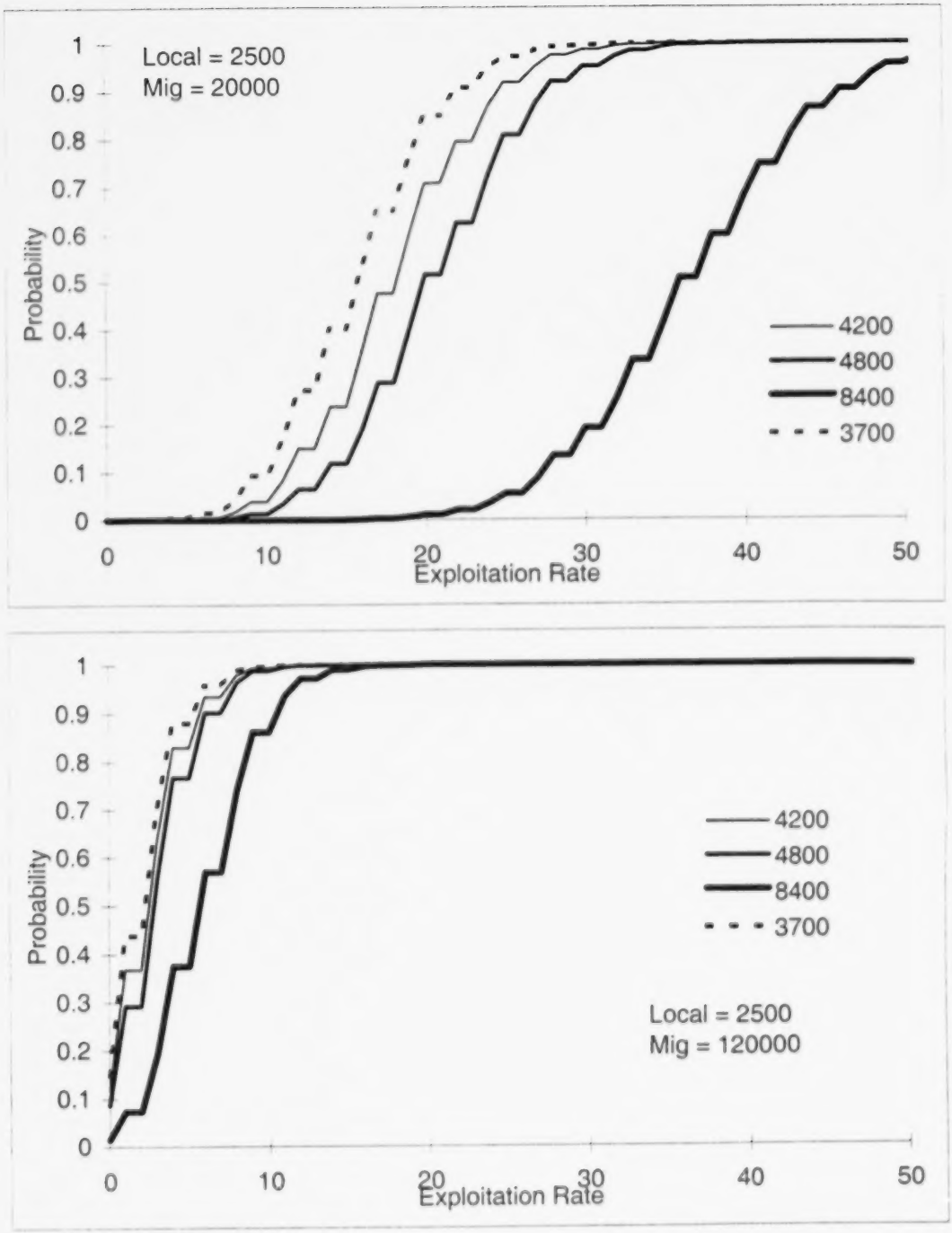



Fig. 25. Relative difference in exploitation rates expected if local stocks are kept constant at 2500 tonnes and migrating stock is 20,000 tonnes or 120,000 tonnes and the TAC varies between 3,700 tonnes to 8,400 tonnes.